The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VII, No. 11 November, 1916

CONTENTS

The Human Machine (Review of a book by Dr. George W. Crile) 483
Annual Meeting of the A. G. A. 493
Improvement of California Orange Groves 493
Mules That Breed, by Orren Lloyd-Jones 494
Iris Breeding 502
Is the Hybrid Origin of the Loganberry a Myth? 504
Heredity in Pellagra 507
Lobed Leaves in Maize, by J. H. Kempton 508
Mutations in the Potato 510
Hand and Foot Prints 511
Mutations in Walnuts 523
Hereditary Nomadism and Delinquency 523
A Yellow Sweet-Pea 523
Coöperation in the Production of California Grapefruit 524
Another German Proposal to Increase the Birth Rate 527
Ewing's Study of an Aphis 527

The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912. Contents copyrighted 1916 by the American Genetic Association. Reproduction of articles or parts of articles permitted provided proper credit is given to author and to the Journal of Heredity (Organ of the American Genetic Association), Washington, D. C.

Date of issue of this number, OCTOBER 27, 1916.

A HOUSE-FLY ESCAPING FROM VENUS' FLY TRAP

The plant will catch and devour any sizable insect that comes along; but small ones, even though the leaves have closed upon them, are allowed to escape as not being worth eating, just as a fisherman throws the small fish back in the stream because it would be more trouble to clean and cook them than they are worth. The above photograph, posed and highly enlarged, shows a house-fly emerging from the interior of the leaf, by crawling between the spikes. (Frontispiece.)

THE HUMAN MACHINE

A Mechanistic View of Life Which Conceives Man as Being Merely a Venus' Fly-Trap Many Times Multiplied—The Kinetic System for the Transformation of Energy—Origin and Function of the Emotions

A REVIEW

ONE school of biologists has long looked upon all life from a "mechanistic" point of view, holding that there is nothing mystical about a living being, but that if our knowledge were sufficient we could resolve its whole life into reactions; we could interpret everything in terms of physics and chemistry, with no unexplainable residue, no "soul" or "vital principle" left over.

Dr. George W. Crile, Professor of Surgery in Western Reserve University (Cleveland, Ohio) has applied this hypothesis to his study of man and has brought the researches of many years together in a substantial volume[1] under the title of "Man—An Adaptive Mechanism." Taking his stand with orthodox Darwinians—one might even say, with primitive Darwinians—Dr. Crile believes that everything in the human body can be interpreted as an adaptation, the result of the long process of evolution and the constant struggle for survival.

"The fact is," he informs us, "that the present form of man is the result of an inconceivably long and tedious process of addition and subtraction, of grafting character upon character in somewhat the same haphazard fashion as in certain mountains in South America stones are thrown by the wayfarer upon a lone Indian grave. Some land securely and augment the mound, while others fall at random and roll away, the desired result being achieved, however, a memorial to the one who lies beneath the pile. If the result of man's haphazard assemblage of organs is to some extent adequate to the needs of his present environment, it is because during the age-long processes of evolution all the fatally awkward combinations have been eliminated by a struggle so keen that the slightest variation in the length of a leaf, the strength of a limb or the color of an egg, has given the victory to a rival species."

A good many geneticists would question the truth of this statement; but the value of Dr. Crile's book does not lie in his contributions to genetics. He does not attempt to show in any instance *how* a certain adaptation has arisen—indeed he seems not to realize that there is any difficulty about this; but in explaining the usefulness of some structure, once it has arisen, he makes out a very plausible case.

"The test of utility," he tells us, "may be applied to internal processes as well as to external manifestations in custom and social forms of man's peculiar mode of adaptation by nervous reactions. On this basis man's claim to a superior place among animals depends less upon *different reactions* than upon a *greater number* of reactions as compared with the reactions of 'lower animals.' Ability to respond adaptively to more elements in the environment gives a larger dominion, that is all."

THE NATURE OF "MIND"

"Mind," the word we use to express the reactions of man's nervous mechanism, "is no phenomenon apart and distinct from other functions of the nervous system. Indeed, mind, as we

---

[1] Man—An Adaptive Mechanism. By George W. Crile, F.A.C.S. Edited by Annette Austin, A.B. Pp. 387, price $2.50. New York, The Macmillan Co., 66 Fifth Avenue, 1916. The photographs of Venus' Fly-Trap, illustrating this review, were made for the JOURNAL OF HEREDITY by John Howard Payne from a specimen furnished by Frederick V. Coville of the Bureau of Plant Industry.

VENUS' FLY-TRAP

This, the most interesting of the insectivorous plants, grows only in a small area on the coast of North Carolina. Although it draws most of its nourishment from the ground and the sun, like other plants, yet it is not entirely healthy and vigorous unless it has animal food. Several of the leaves on this plant are closed, having caught insects which they are now in the process of digesting. The process of digestion usually requires two or three weeks, after which the leaves open to reject the remains, but usually are never again active. Sometimes, however, the same leaf has been made to digest several insects in succession. (Fig. 1.)

find it in the 'lower walks' of life, is not confined to animals. Many plants exhibit in response to external stimuli protective reflexes which are analogous to the nervous reflexes of man. Notable among these are the drooping leaves of the sensitive plant when it is lightly touched, and the movements by which the Drosera and Venus' Fly-Trap capture and digest their prey when they are excited by the touch of an insect."

"In other words, the complex organism differs from the simple only in the number of its reacting units and their attunement. It would seem, therefore, that the manifold reactions of man differ only in number and complexity, but not in principle, from the simple adaptive reactions of Venus' Fly-Trap."

This plant "possesses one of the most remarkable adaptive mechanisms in nature." It "evinces just as much power of perception and discrimination as is shown by the amoeba; indeed, almost as much as is shown by many highly differentiated organisms, such as the frog, for example. The fly-trap catches flies, eats and digests them and ejects the refuse. The frog does the same, responding to the adequate stimulus of the sight of a fly just as the fly-trap responds to its touch. Both the frog and the fly-trap catch insects by comparable motor mechanisms. Each depends on an adequate stimulus for the excitation of the mechanism as a result of which stored energy is set free to be manifested in the fly-catching reflex. Each then digests and assimilates the caught insect and when hungry catches another insect.

"If the reactions of the human organism be reduced to their simplest terms, probably none will be found more

intricate than this food-catching reaction of Venus' Fly-Trap and the frog. The principal difference between these three living mechanisms is rather a difference in the range of activation by environment, resulting in the frog and in man in a larger number of reactions which in turn involve more complex effector mechanisms than are possessed by the fly-trap. Each reaction of man doubtless has more component parts than each reaction of Venus' Fly-Trap, just as a large house contains more bricks than a small house.[2] The most complex machine ever invented by man looks like a grotesque monster to the savage; yet its complex movements are compounded of the two simple movements of translation and rotation."

THE WORKING OF THE MACHINE

If we similarly try to analyze the reaction of the fly-trap, we find three distinct stages:

1. The application of an adequate stimulus from without, *i. e.*, the touch of a fly.

2. Conduction of this stimulus from the tip of the sensitive filament to the motor mechanism of the plant.

3. The chemical and motor end effect, involving all the acts and organs used in closing the lobes and the killing and digestion of the insect.

"In the three separate stages of *adequate stimulus*, *conduction* and *end effect* which compose the reaction of Venus' Fly-Trap, we find all the essential factors which enter into the life activities of man. Under *adequate stimulus*, for instance, are included the activating stimuli produced by heat and cold, dust, débris, microörganisms, food, air, water, light, poisons, blows—and by certain physical and chemical changes within and without the body, to which man through 'evolution' has become adapted through the creation of an adaptive response. *Conduction* is supplied by the central and autonomic nervous systems, that is, by the organs of touch, taste, sight, smell, hearing, pain, and by the chemical receptors for the initiation of certain reactions of chemical control. *End effects* are found in all the vital processes of motion and emotion, muscular activity, chemical change, psychic states, growth, nutrition, reproduction, thought, invention, social forms, government, war, religion, business, in short, in all the activities by which man's life is distinguished from the immobility of the rock."

Such is the attitude toward life of the mechanistic school. It is, of course, open to criticism, but this is not the place to criticize it. Let us rather examine the details.

"As we have seen, the presence of the adequate stimulus is the first requisite for reaction. As the lobes of the fly-catching plant close only upon the arrival of the insect stimulus, so every conceivable act, thought, or function, of the human body, requires an adequate stimulus for its manifestation, that manifestation depending absolutely upon the previous experience of the organism or of its species with that stimulus. That is, the response to any stimulus depends wholly upon the biologic necessity which led to its

---

[2] It is well known that Venus' Fly-Trap, the sensitive plant (*Mimosa pudica*), and other plants possessing the power of motion can be chloroformed, when their movements are stopped just as in animals. On this point Dr. Crile contributes the following note giving a "comparison of anesthesia in plants possessing a motor mechanism and in animals:"

"In peripheral nerves after exposure for varying periods of time to vapors of the various fat solvent anesthetics, *e. g.*, chloroform, ether and ethyl alcohol, there is an increase in the amount of potassium in the medullary sheaths as shown microchemically by the potassium reagent of Macallum. A similar increased amount can be demonstrated as the result of mechanical or chemical injury. In those plants possessing a motor mechanism, *e. g.*, *Mimosa pudica* and *Dionaea muscipula*, after exposure to the same fat solvent anesthetics there is a marked increase in the demonstrable potassium compounds. This increase occurs in the guard cells, in the chlorophyll granules, in certain modified conducting elements, but to the greatest extent in those areas of the plant which are most active in producing motion and which upon stimulation show a considerable turgor. Lipoid substances as demonstrated by osmic acid and scarlet red have the same distribution as the potassium compounds. In plants as in animals the lipoid substances which contain potassium, *e. g.*, lecithin and cholestrin, after the application of these anesthetics become so altered in their physical constitution that the contained potassium compounds can enter into the chemical combination with the reagent applied."

LEAVES OF THE FLY-TRAP

On the inner surface of each are three or four delicate hairs or filaments, not visible in the photograph. A heavy touch of these, such as might be made by a falling stick, usually produces no result; neither does a light touch such as a raindrop would give. And even a single touch of the right firmness causes no activity—so carefully is the plant protected against wasting energy on "false alarms." But if it is touched delicately twice in quick succession, as might be done by a crawling insect, the two lobes of the leaf immediately close and begin to secrete a digestive fluid. For a while the victim can be heard buzzing frantically inside; then the sides of the prison collapse and pin him firmly; a few weeks later nothing remains but his skeleton. (Fig. 2.)

evolution. The response to a sharp blow by pain and retreat from the offending point; the response to an insect-like tickle by the desire to scratch; the response to a soft, caressing contact by pleasure and approach, are all specific to the species and the self-protective necessities as a result of which they were evolved in the organism. Similarly, the more obscure and delicate responses of thought and sentiment, of 'study,' 'invention,' 'ambition,' 'industry,' 'joy,' 'sadness,' 'remorse,' are all dependent upon specific stimuli in the environment and are specific to one or another of the biologic purposes of self-preservation, nutrition or procreation."

THE USE OF TICKLISHNESS

Some of these reactions to stimuli may have been of use once but are of little value under the conditions of modern civilization; "for just as the organism is slow in evolving adaptations to newly developed factors in the environment, it is slow in discarding adaptations to an older environment, even such as may be a hindrance to life under present conditions. Such a relic of prehistoric peril is the tickle reflex. It is more strange than appears at first glance that the tickle reflex can be excited only in certain parts of the body, by but two types of tactile impression, and that it is invariably accompanied by a self-protective reaction. One type of the tickle reflex is elicited by a light running motion on the surface of the skin, which produces a sensation like that produced by a crawling insect, with an irresistible desire to scratch or rub the affected part. A sharp impact causes pain, but if the adequate stimulus of contact which simulates the crawling of an insect be applied again and again in the same spot, it will cause each time the same tickling sensation. This reflex was undoubtedly developed at a time when insects were a great menace to life, and when only those individuals who evolved an effective defense were able to prevail. It may even supply an explanation of man's loss of hair in the upward march, since the presence of hair would provide ambush for the insect enemy, and its loss, together with the evolution of the tickle sensation, would greatly facilitate defense."

"A second type of tickle reflex is elicited by heavy penetrating pressure in the region of the ribs, the loins, the base of the neck and the soles of the feet—the pressure simulating the penetrating contact of a tooth-shaped body. The reaction in this case is a violent discharge of energy in the form of laughter with cries for mercy and frantic muscular efforts to be free if the stimulus be continued. If one were tied hand and foot and were vigorously tickled for an hour, he would probably be as completely exhausted as if he had run a marathon race or sustained a crushing injury; indeed, victims of torture in the Middle Ages were often killed by prolonged tickling.

"The fact that these ticklish areas are found in those parts of the body which are still and must always have been the points most frequently attacked by savage beasts leaves little doubt that this reaction developed at a time when man's progenitors, like the carnivora of today, fought their enemies face to face with tooth and claw, and that this mechanism was acquired as a means of protection against valiant foes."

THREE KINDS OF REACTIONS

Tears, sneezing, coughing and vomiting are among the other protective adaptations which Dr. Crile describes as being based on contact stimuli. There are other adaptations which are based on chemical stimuli. And finally, there is a third class of reactions, much greater in extent, which is based on the stimulation of what he calls "distance ceptors." He explains:

"Adaptation to environment in some species of animals, such as the oyster, is secured mainly by reactions to stimulation of the contact and chemical ceptors only; but in most animals there has been evolved a third method of adaptation to environment by which they are directed toward beneficial objects in their *distant* environment and away from those that are harmful, thus

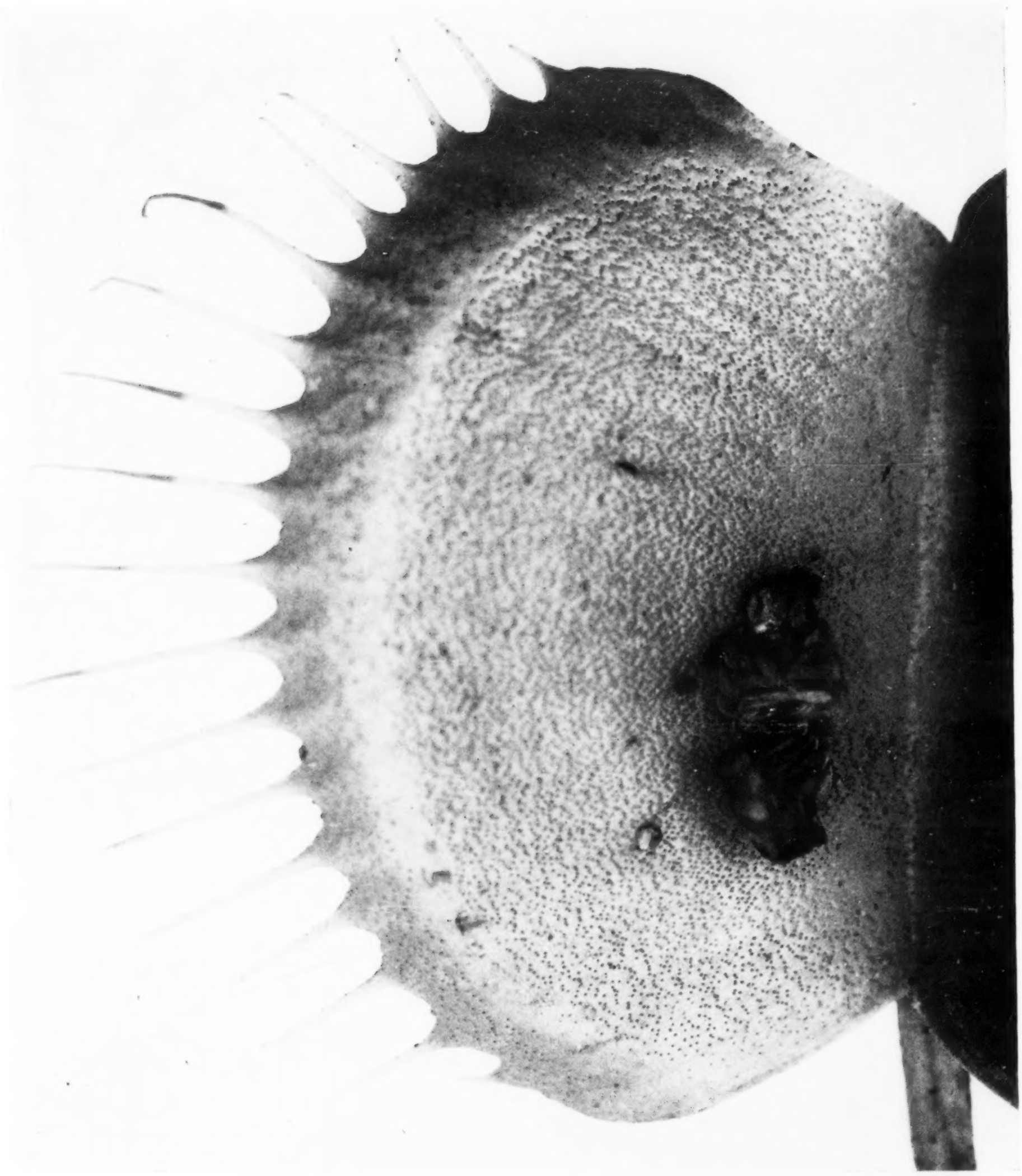
securing a quicker and surer adjustment than would be possible through contact and chemical ceptors only." In the third class of stimuli the animal *as a whole* responds, whereas responses to the contact and chemical stimuli usually involve only a part of the organism. This does not, however, change the essentially mechanical character of the occurrence. "The flight of the giant water buffalo at the sight of a lion, or the charge of the lion at the sight of its prey, is as automatic a reaction as is the withdrawal of the limb of a rabbit from the sharp prick of a thorn." The emotions offer good illustrations of this third class of stimuli. Fear, for example, is said by Dr. Crile to be intended to prepare the body to seek preservation by flight. "Striking evidence of the truth of this assumption is afforded by the fact that fear is experienced only by animals which depend for self-defense and species-preservation upon a swift locomotor reaction. The skunk, for example, whose chief means of protection is its odor; the porcupine, defended by its quills; the snake which repels its enemies by its venom; the turtle which is securely encased in its shell; the lion and the elephant secure in their superior strength—exhibit little fear, if any. On the other hand, the rabbit, the bird, the deer, the horse, the antelope, the monkey, and man—species which have ever had to struggle for their existence against stronger or swifter enemies—these are the animals which preeminently exhibit fear and an irrepressible desire to flee from danger."

The mechanism of fear is further discussed, and its effects are declared to depend largely on increased activity of the thyroid gland, the adrenals, the liver, and other glands, the secretions of which are either increased or diminished. "In the light of this evidence many phenomena of fear and of other emotions may be explained. It is known, for instance, that men and animals under the stimulus of strong emotion possess an extraordinary amount of physical strength. This is explained by the fact that fear drives certain organs and inhibits others, so that every particle of available energy is concentrated upon the fighting mechanism. The advantage that this power must have given to prehistoric man in his struggles against superior foes in a wild environment is apparent to anyone who will allow his imagination to revert to those days of supreme physical contest. But that the tendency should persist today, in spite of the disappearance of most of the stimuli to active physical combat, so that, at the slightest hint of danger, man's energies are drained, exactly as in the days of physical struggle, is one of the misfortunes of our insufficiently adapted state.

THE EFFECT OF FEAR

"So strong is the force of these ancestral acts, so firmly established the action pattern of muscular response to fear stimulus, that now, whether a business catastrophe or an attacking enemy threaten, fear is expressed in terms of the ancestral flight to safety or fight for life which took place in the remote brute period of human history. In spite of the fact that by harnessing the forces of nature, and by social coördination, which reduces the number of motor reactions, man has progressed vastly in his methods of acquiring food and avoiding danger, his body still responds to the threatened moral or financial disaster, as if the old need for physical contest remained. His heart beats wildly; his respirations are quickened; he trembles and turns cold; his knees shake; beads of sweat stand upon his brow; he is pale and his mouth is dry; he feels faint and he may collapse. Whether the cause of fear be moral, social, financial or intellectual, the result is the same."

"As fear activates the body, so all emotions and psychic states activate the body and exhaust energy in proportion to the degree in which they represent the physical activity attendant upon the phylogenetic forms of self-defense. As fear recapitulates the ancestral act of flight from the enemy, so rage or anger recapitulates the act of attack and in like manner activates



THE REMAINS OF A FEAST

None of the leaves of the plant here pictured contained flies, but several of them held the remains of the little land crustacean commonly known as the sow-bug. The photograph above shows an opened leaf, much enlarged, with the chitinous skeleton of its victim, from which all the meat has been dissolved. The acid secretion of the plant is almost colorless and slightly mucilaginous. The most common food of the plant, when wild, is beetles, but it will eat spiders and almost anything that comes too close to it. Obviously, however, flies, bees, etc., more frequently escape than do insects which have less power of flight. (Fig. 3.)

the muscles that would be used were the physical fight made."

From such cases as have been cited Dr. Crile concludes that "the adaptation of man and kindred animals to environment is secured by a series of physical and chemical reactions which are the outward expressions of a transformation of energy, by which the forces latent in food products that have been appro-

priated and stored in the organism are released to produce heat and motion." He then undertakes to find the mechanism that thus transforms energy. A long series of experiments, which cannot be described here, leads to the conclusion that "only the brain, the thyroid, the adrenals, the liver and the muscles are chiefly concerned in the transformation of energy." "They merit therefore the distinction of being termed the *kinetic system.*"

This brings him to his particular field of medicine and surgery—the field which he primarily wanted to investigate, for he felt that medical science was falling behind, because of its failure to adopt an evolutionary outlook.

"The postulate that there is in the body a kinetic system, consisting mainly of certain organs, which are driven by the stimuli of the outer and inner environments of the body, throws light upon many problems of the medical clinic, as well as of human relations. According to this postulate, the body is a mechanism integrated and driven by the brain in response to adequate stimuli—contact, distance and chemical—arising within and without the body. The phenomena of health and disease are manifestations of the activity of this system. When the body mechanism is driven at a moderate speed by an environment to which the capacity of the body is perfectly adjusted, the result may be compared to that following the driving of any other machine by a careful and considerate master—a maximum of work done, with a minimum of wear and tear on the parts. When for a short period of time or continuously the driving is at an excessive pace, there results a sudden or a gradual breakdown, involving always the weakest link in the mechanism."

The observation that the degenerative diseases to which man is subject are not the same, in general, as those which attack woman, leads to an interesting speculation on the difference in nature of the kinetic systems of the two sexes. "The adrenals preëminently control the mechanism for increasing motor efficiency during short periods of increased transformation of energy. The adrenals are the organs most heavily involved in muscular work. On the other hand, the thyroid controls the mechanism which regulates energy transformation during longer periods of increased activation. It is known that the thyroid enlarges during sustained periods of increased activity, particularly during infection, adolescence and pregnancy. Throughout the ages of evolution, the male has been chiefly the motor member of the family; he has been, not exclusively, but for the most part, the hunter, the fighter, the searcher for food—activities which have required increased transformation of energy during short periods of time, with proportionally heavy demands upon the acid-neutralizing mechanism of the body. The female, on the other hand, has borne the burden of procreation and of the lighter but more constant domestic tasks, and has been correspondingly dependent upon the mechanism for sustained physiologic efficiency, represented chiefly by the thyroid. This age-long differentiation may conceivably have led to a corresponding differentiation in the physiologic expression of emotion, with a corresponding differentiation in the diseases caused by emotion. According to a striking statement made by Loeb, 'Man and woman are, physiologically, different species.'"

Dr. Crile goes on to illustrate the all-inclusiveness of the mechanistic philosophy.

"If emotion, particularly fear, causes such far-reaching metabolic disturbances, why does it not produce even more baleful consequences? Indeed, why has not emotion wrecked the race? Is it because there are now certain agencies at work in society, which hold in check this harmful tendency, as immunity and phagocytosis protect the organism against bacterial menace, and as the custom of wearing clothes and building houses is a protection from the dangers of cold and wind and hostile strangers? Has there been evolved in man some counter-adaptation which provides a partial protection against self-destruction from the too-long-retained motor adaptation which we term 'emotion?'

THE FLY-TRAP IN BLOOM

The plant produces its white flowers in July and August; in the fall it loses it long-stemmed leaves (such as are shown in Fig. 1), which appear in the spring, and in their place puts forth short, broad-stemmed leaves such as are shown in the above drawing. Leaves of this form seem to be more suitable for withstanding the winter climate, but they are much less active in fly-catching than are the spring leaves. The plant can be cultivated in greenhouses without much difficulty, and makes a fascinating object of study. Illustration from Crile. (Fig. 4.)

"In attempting to find an answer to these questions, we are led to contemplate the fact that physical benefit is derived from those factors in life, which solace and reassure the mind, which 'rejuvenate the spirit,' which dispel worry, and which substitute faith and tranquillity of mind for turmoil and terror. . . . On the principle that fear causes the dissipation and faith the conservation of potential energy, we can understand the far-reaching and abiding benefits of religion in all ages, among all peoples, throughout the whole human race, as far back as we have any record. . . . In thus placing faith, hope and charity on the same plane with muscular reflexes, in their power to conserve the life of the race, we but give them their proper place in evolution as adaptations which have arisen coincidently with the need for such modifications."

THE BRAIN-MECHANISM

We now return to the fly-trap for another lesson.

"We know that the brain contains the mechanism that drives the body; we know that environment drives the brain and that environmental forces reach the brain through the mediation of the sense organs. But what is the mechanism within the brain by means of which a given stimulus causes different effects in different brains? Why will one man run away and another attack on receipt of identical stimuli?

"We postulate that the adaptive reactions of the organism are executed by mechanisms, each of which, like a wireless station, awaits the arrival of the specific impulse which is to awaken it to specific response."In another paper he describes the brain as an organ that contains "innumerable patterns, each representing a mechanism for the performance of a specific act, and that the brain cells supply the energy—electric or otherwise—by which the complex act is performed, that the energy stored in the brain cells is by an unknown mechanism released by the force that passes over and activates the brain pattern; through an unknown property of these brain patterns each stimulus causes some change in the brain pattern in passing through it so that the next stimulus passes with greater facility. This property of facilitating a stimulus increases with repetition that particular mechanism's reception of the particular stimulus. This is the basis of education, of training, of establishment of the conventions, conduct, behavior, government—in short, the total behavior of the individual."

After describing the similarities between the reaction of Venus' Fly-Trap and a human reaction, Dr. Crile says:

"In Venus' Fly-Trap but one receptor and one effector mechanism has been evolved for but one adaptive reaction. In man many receptor and effector mechanisms have been evolved for numerous reactions in response to numberless stimuli.

MAN A COMPLICATED PLANT

"If it were necessary for Venus' Fly-Trap to catch its food by running, instead of by passive attraction, the plant would doubtless have evolved a mechanism coördinating the organism for running—in other words, a brain. The difference between Venus' Fly-Trap and man is the difference between the number of mechanisms possessed by each. A multiplication of the single action pattern of Venus' Fly-Trap equals the mechanism of man."

Thus is man reduced to a complicated sort of fly-trap.

Without going into the genetic and philosophical difficulties which this view involves, it may be said that as a working hypothesis in the field of medical and surgical research, the mechanistic view is likely to be exceedingly fruitful for, as Dr. Crile points out, medicine has developed as a sort of household necessity, without any very broad biological foundation: "lacking the resources of assured scientific data or the support of coördinated methods, it is no wonder that it is even now in a somewhat chaotic state." Dr. Crile's own contributions are noteworthy, and this review has unavoidably done him an injustice, in passing over masses of technical experiments which form the most original part of the book, and emphasizing biological principles which

are in many cases not new, but merely used by the author as stepping stones. Dr. Crile's own results are sufficient to prove that the mechanistic philosophy will lead to some interesting advances in physiology, surgery and medicine, even if its genetic foundations are not fully understood. And the results obtained by a great number of other investigators in the same field, while perhaps not so immediately put into practice as, for instance, Dr. Crile's method of preventing surgical shock, are not less of fundamental importance.

It is really astonishing that the evolutionary study of physiology should have been confined to such a small number of workers, during the last half century, and should have made so little impression on the layman, or even on the medical profession. Such books as the one under review, packed as it is with interesting facts and fascinating theories, of which only a few have been suggested here, cannot help but be of great use in stimulating that sort of study. And it is on exactly that sort of study—the study of man as a species, in relation to other species and to his own past history—that the social progress of the next century will largely depend.

Annual Meeting of the A. G. A.

Two general sessions of the American Genetic Association will be held in New York, December 26–30, in connection with the meeting of the American Association for the Advancement of Science. In addition there will be a number of meetings of each of the sections—plant-breeding, animal-breeding and eugenics. Members who desire to present papers should notify the secretary as soon as possible. Papers of suitable character will be published in the JOURNAL OF HEREDITY, particularly if they lend themselves to good illustration. As it appears that the program will be full, the length of papers will be limited to twenty minutes, unless special notice is given. Full details of the meetings will be published in the next issue of this journal.

Improvement of California Orange Groves

Owners of the largest orange groves in Southern California have already adopted the plan of keeping a record of the performance of each individual tree, and eliminating any trees that do not prove to be good producers, usually by top-working them with select buds. So far, however, it has not been found possible to get many of the owners of small groves to adopt this process. The California Fruit Growers' Exchange is now planning to assist the growers in securing the record of trees in these small groves, taking advantage of the fact that small growers do not pick their own fruit, but entrust the task to the local association of the exchange, which sends out a trained gang of men to pick the fruit. It is now proposed to add to each picking crew a man whose duty will be to make a record of the production of every tree; and this report, furnished to the owner of the grove, will enable him to supplant the bad yielders with trees of a better strain, in many cases by topworking the drone or undesirable individual tree. The exchange has for several years been working on the problem of standardizing the citrus *pack;* a cooperative and organized effort is now being made to standardize the *production.*

MULES THAT BREED

Occasional Cases Reported, Some of Them with Good Evidence—Two Recent Cases in America—Studies of Germ-Cells Indicate that Chance of Mule Breeding is Very Slight

ORREN LLOYD-JONES

Associate Professor of Animal Husbandry, Iowa State College, Ames, Iowa

DURING the three or four thousand years in which mules have been habitually produced, there have been many conflicting statements of fact and theory in regard to the question of possible fertility among these animals. Numerous incidents and cases are on record calculated to prove that mules occasionally exhibit generative powers. The affirmative side of the case may be opened by the French zoologist André Sanson ('88), who uncompromisingly maintains (Vol. III, p. 145) the occasional fertility of female mules. He says "it does not seem inadmissible that the males of the same origin as the females which show themselves so easily fertile, would not themselves behave similarly," and again "if there are fertile males, as we are sure at present that there are fertile females . . ." Sanson's claims are unusually broad—most writers are more conservative.

N. S. Shailer ('95) comments on the "singular fact that in only two or three cases have mules become fecund." Cossar Ewart ('93) states that mules are generally incapable of procreation, "though some exceptions to this rule have occurred." Whitehead ('08) in discussing the mule makes the parenthetical remark that "the cross between a female mule and a stallion is known to have resulted in offspring."

Stories accompanied by statements of eye-witnesses, of the birth of a foal by a mule, and affidavits as to the true hybrid nature of the mother, present obvious difficulties to those who would summarily set aside the whole matter of fecund mules as a thing of myth and anecdote. At the time of publishing the book on *Horses, Asses and Mule Breeding* in 1895, Tegetmier was a thorough disbeliever in all such cases, but in 1897, speaking of fertile mules, he mentions a case reported from Mexico and says that "this is one of the most detailed accounts of fertility in mules that has come under my notice," and urges caution in opinionating.

PREJUDICE IS STRONG

Skinner (Youatt, 1854) examined very carefully the first-hand evidence in regard to the celebrated Norfolk case of a breeding female mule and proved to his own satisfaction its authenticity. He also recognized the deep-seated prejudice which people have against giving credence to fertility among mules for he naively remarks that "Whatever doubt may arise hereafter, there is none now, of the truth of this case" (p. 432.) In this case the owner had noticed an abdominal enlargement in his female mule and had adjusted the shafts and harness to accommodate it, "but never suspected the mother's being in foal because it was contrary to nature." On April 23, 1834, she unexpectedly produced a colt. The mule had previously pastured with a 2-year-old stallion. Subsequently on August 13, 1835, the same mule produced another colt, a female. Both colts seemed normal, but died when a few months old.

Mr. Gun, an English military veterinarian in India, and apparently a faithful and efficient exponent of his profession presents (*Field*, September 17, 1898) in elaborate detail the events accompanying parturition in an Indian transport mule. This is indeed a case hard to refute.

Two cases recently reported have come before me and I have been able to

A HINNY WITH TWIN COLTS

The large animal here shown is said to be the offspring of a half-blood Percheron stallion and a black Spanish jennet, and her twin foals (one of which lived only a few days) are supposed to have been sired by a gray mammoth jack. The colts would therefore be three-fourths ass and one-fourth horse. (Fig. 5.)

collect some evidence on the matter, in the shape of statements and photographs.

One case first appeared in the November issue of the *American Journal of Veterinary Medicine*, Chicago, and again in *American Farming* for February, 1916. The facts presented below were furnished me by the owner and the veterinarian who attended the case. J. M. Bryant, of Quincy, Ind., about nine years ago bred a dark chestnut "half blood" Percheron stallion to a black Spanish jennet. The hinny thus produced is now 8 years old, 14½ hands high and weighs 900 pounds. Her whole aspect is very ass-like, especially her hind parts, but Mr. Bryant says her head has more the appearance of her sire—her ears being dark chestnut color, the same as the stallion. The tail shows a good brush or switch while the ass has a "rat tail." She has never brayed like a jennet. Some have doubted her breeding until they heard her voice, which resembles more the neigh of a horse. Twice before the present case this female produced foals, but in both cases the birth was abnormal and the colts died. Dr. L. A. Ray, the veterinarian who attended the birth in question, says of these earlier foals, "They were much deformed and were unable to swallow, and one had a double head from the eyes down."

This "hinny" was bred to a gray mammoth jack on July 7, 1914, and on July 11, 1915, produced the pair of twins shown in the cut (Fig. 5). The twins were both females. One was 25 inches high, black with white points, and lived only 7 days. The other was 30 inches high and gray in color. Dr. Ray on February 17, 1916,

SUPPOSED CASE OF A FERTILE MULE

The female is said to be out of a standard bred mare by a mammoth jack, which would make her a true mule. Bred to a black Percheron stallion, she is reported to have given birth to the colt shown, which would therefore be three-fourths horse and one-fourth ass. A better photograph of the colt is reproduced in the succeeding illustration. (Fig. 6.)

reports this colt as "very peculiar in make-up and very unthrifty." A letter from the owner, April 26, reports this gray colt (three-fourths ass and one-fourth horse) as doing well: "she seems to have the large bone of the horse above the knees, and below the knee the foot is small like a jack; it shows the Percheron one-eighth in the square hip. The colt makes a very peculiar noise, unlike any animal I ever heard."

Mr. Bryant has bred the "hinny" this year to a spotted Welsh pony and hopes to get a foal three-fourths horse and one-fourth ass. He says he has been about 10 years breeding for a "grade mule"—and if the present colt lives he believes he will "have the breed started."

Through the courtesy of Glen Hayes, editor of *American Farming*, the following case was called to my attention; the statements are quoted from correspondence with the owner, D. W. Sullivan, of Weed, Cal. Mr. Sullivan states that the female in Fig. 6 is out of a standard bred mare by a Mammoth Jack. This "mule" was put to a black Percheron stallion and on May 31, 1915, produced the male foal shown in the picture. The picture was taken when the colt was 3 days old. He is doing well at the present writing, and gives promise of developing into a valuable animal. He has a tail like a mule, and his feet are very small, long and narrow, again a mule-like trait. The owner states that "his actions are

A REPUTED "GRADE MULE"

The colt pictured in Fig. 6 is here shown at the age of one and one-half years. There is little visible evidence of the one-fourth ass blood which he is supposed to possess; but his owner says that his feet are mule-like, as are his actions. There are physiological reasons for doubting the accuracy of all stories of mules that breed, but many students have been willing to admit the fertile mule as a possibility. (Fig. 7.)

more like a mule than a horse. I have bred this mule again this spring and she only took the horse once. I think she will have another colt; if so I intend to start a breed of that kind."

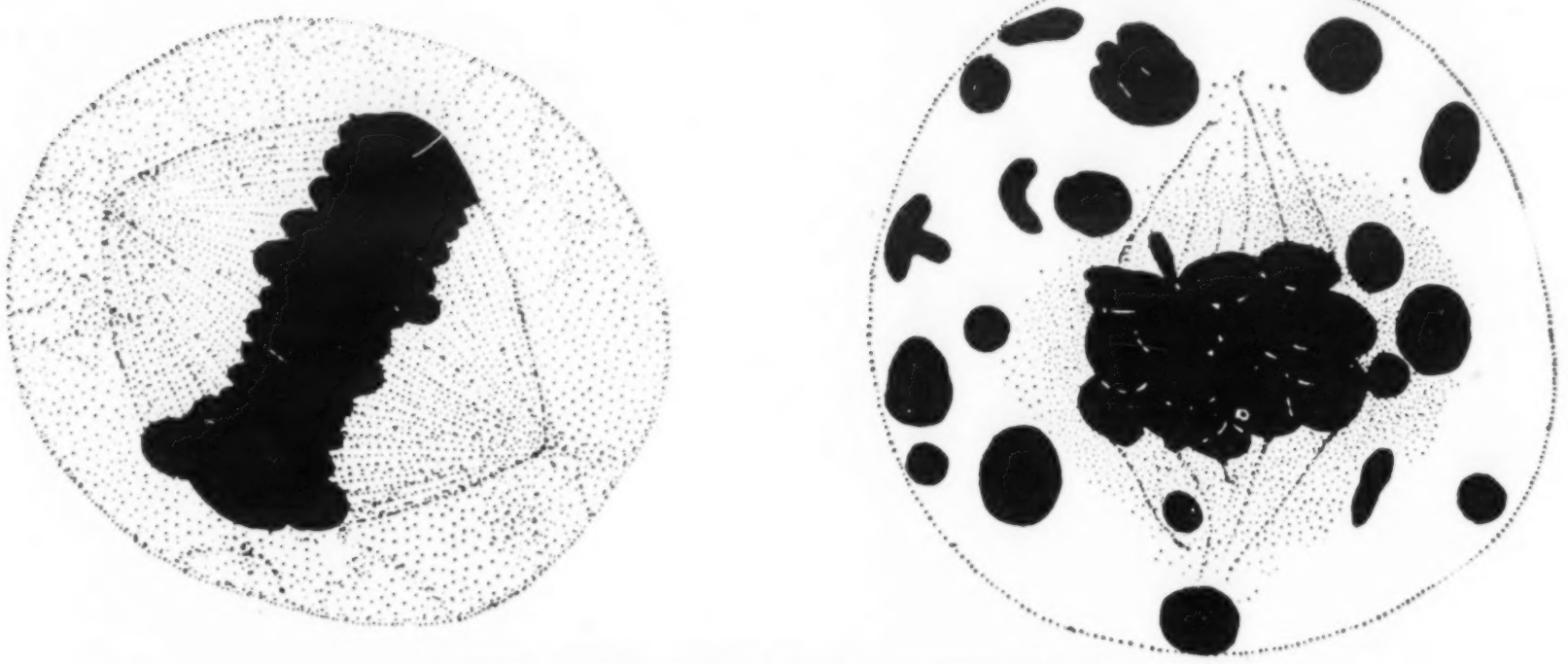
PHYSIOLOGICAL STUDIES

The ovaries of equine hybrids have not been frequently examined as have the testes. Ewart examined the ovaries of a zebra-horse hybrid of 10 years of age which had died. He found Graffian follicles present, one of them being $1\frac{1}{4}$ inches in diameter. A ripe follicle in a 16-hand mare is about $1\frac{3}{4}$ inches in diameter. "From the appearance of this follicle it might well have contained an almost ripe ovum." This case has encouraged Prof. Ewart to say that "occasional fertility among female mules is not inconceivable." Habenstreitt worked on the ovaries of a female mule and found follicles but no ova. Female mules exhibit regular periods of oestrum, but the exact seat of the cause of this cycle of changes is not clear.

But despite this chain of direct and circumstantial evidence the body of scientists has always been sceptical, and even mule breeders themselves as a class are inclined to discredit reports of fertility among mules.

The negative side of the question is stated boldly by Ayerault ('91), who unhesitatingly asserts that all cases of supposed fertility are errors in observation or recording. He says (p. 152) that "In Poitou, where 50,000 mares are annually used for mule production, fertile mules are unknown, although . . . they are in the best possible condition to be fecundated," since they are constantly pastured with stallions. In support of the negative side there are in general two lines of argument which are followed.

1. All reported cases are cast aside as mere myth and anecdote, or as due to



WHY THE MULE IS INFERTILE

When body cells divide there is no preliminary pairing of chromosomes. But when germ cells are formed each chromosome pairs with its mate as a necessary preliminary to division. In the case of the pure species this is a regular and orderly process as shown in the figure to the left. But in the germ cell divisions of the mule this is impossible as shown in the figure to the right. One trouble is that the hybrid has received nineteen chromosomes from his dam, a mare, and thirty-two from his sire, a jack; and when the chromosomes come to pair off there are not enough of the right kinds to pair. In addition there is an incompatibility between those "pairs" that are present and pairing is difficult or incomplete. The whole machinery of the cell is, therefore, upset and the cell itself destroyed. Camera lucida drawing, enlarged 3,000 times, from J. E. Wodsedalek (Biol. Bull., XXX, pl. I). (Fig. 8.)

faulty observation, or as due to wrong interpretation of facts. The cases reported are so rare that this is not a difficult undertaking.

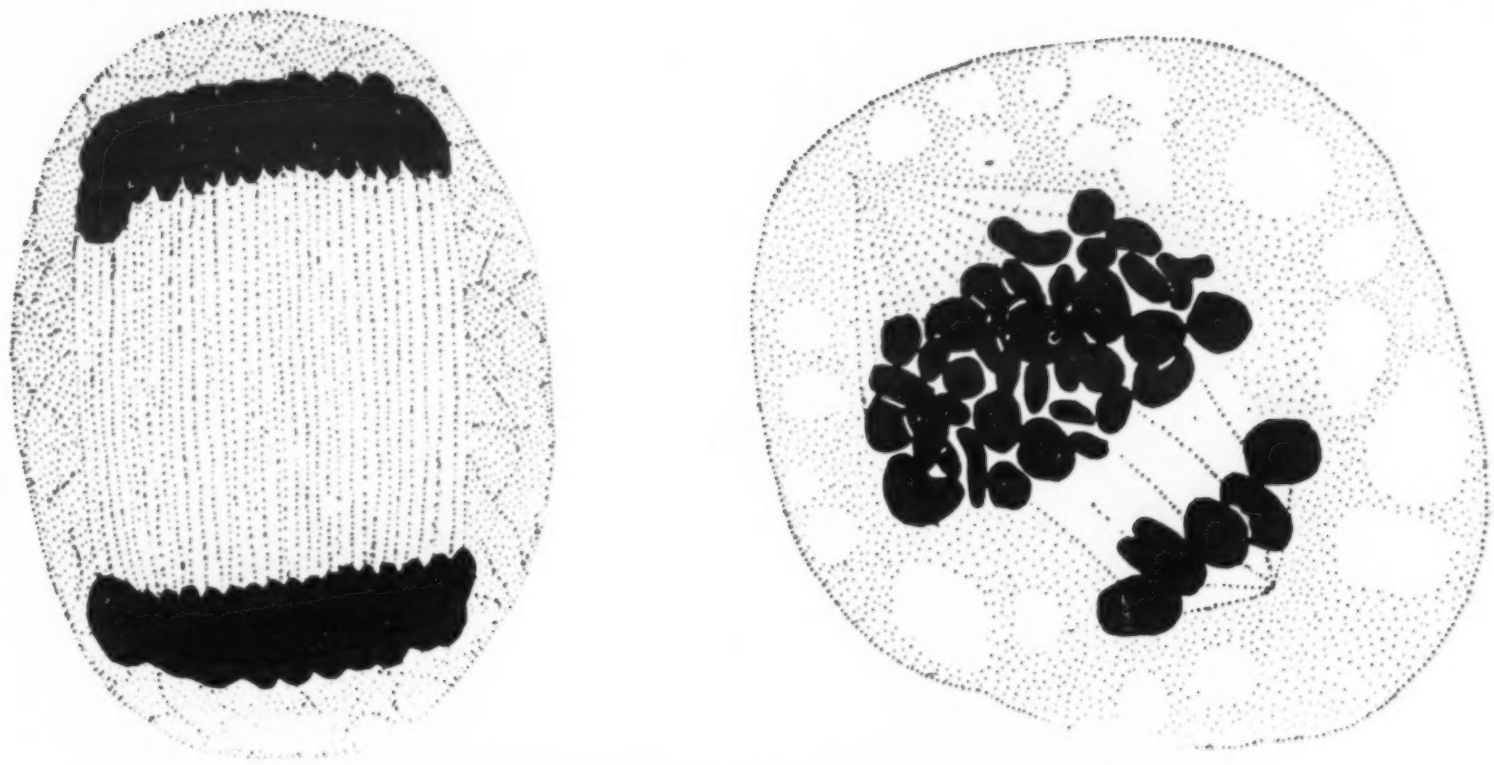
2. The germ glands, as well as the secretions discharged therefrom, of the hybrids are studied histologically and cytologically. These studies indicate a deep-seated derangement of the cell divisions which would, in normal, fertile animals, give rise to the fully developed germ cells.

SOME STRONG EVIDENCE

1. As to the first mentioned line of attack calculated entirely to disprove fertility among mules, *i. e.*, throwing all reported cases out of court as errors, it must be said that the facts as shown above in some cases are too strongly supported to be regarded as only fiction, and to be cast lightly aside; some way of "explaining" such cases is necessary. Those unwilling to give credence to the stories of fertile female mules, explain the "supposed cases" in one of two ways.

(*a*) The female may have produced a hybrid colt, but the real nature of this fertile female may not be known. Frequently horses of mixed breeding are seen which exhibit asinine traits of character, both externally and in disposition. If a female of this nature became pregnant, she might well be mistaken for a fertile mule. Such a case is doubtless the well-known instance in the Acclimatization Gardens in Paris. A female—supposedly a mule—produced foals when mated with both the horse and the ass. She was sold to the Gardens by some Algerian natives who alleged her to be a mule. It developed later that it was extremely doubtful whether the animal was a mule. The particulars of her parentage, etc., are utterly unknown, except as narrated by the Algerian horse traders and there were, as shown in a photograph reproduced by Tegetmeier and Sutherland, but vague suggestions of mule-like character about her. Her foals by an ass appeared to be ordinary mules and were sterile; her progeny by the stallion were horses which proved fertile.

In fact it is quite possible that the Sullivan case from Weed, Cal. (Fig. 6), belongs in this category. On examining Fig. 6 many readers will doubtless at



ORDER GIVES PLACE TO CHAOS

At the left is a perfect cell, showing the normal anaphase, half of the chromosomes going to each end. At the right is an abnormal division, due to the fact that the mule (a male, in this case) has not received the same number of chromosomes from each parent. Chaotic cell-division seems regularly to occur in adult male mules, so that all the germ-cells they produce are destroyed by internal causes. It is, therefore, doubtful whether a male mule can ever produce offspring. Camera lucida drawing, 3,000 times natural size, by J. F. Wodsedalek (Biol. Bull. XXX. pl. iv). (Fig. 9.)

once challenge the real hybrid nature of the dam. The "rat tail," the sparsely developed mane, the slightly excessive length of ear, as well as some lineaments of face and body difficult to describe, all suggest "mulishness" to be sure, but unprejudiced observers will pronounce her a very horse-like mule. To believers in telegony these cases offer little difficulty. Tegetmeier quotes Capt. Hayes, "a practical authority," as saying that "those animals which have been mistaken by superficial observers as fertile mules are really in most cases offspring of mares that have previously been bred to donkeys, and have given to their foals characteristics of their former lovers." Tegetmeier then proceeds to say in regard to the above female at the Acclimatization Gardens that "it is not a case of a fertile mule breeding, but that the animal is really an ordinary mare whose female parent was influenced by a first alliance with an ass."

Even though we do not now accept telegony as a fact, it is clear that here is a possible source of confusion in this debated field of fertility among mules, since belief in it by breeders of the past would tend to influence their accounts.

Disbelievers may also call Mr. Bryant's fertile "hinny" into question on a similar count, but it is interesting that this case hangs on the other horn of the dilemma. It is only with considerable circumspection that we can discover evidence in the appearance of this female which would enable her to establish a biological kinship with the nobler race.

ADOPTED OFFSPRING

(*b*) A second way in which supposed cases of fertile female mules may be accounted for is as follows:

The female in question may be a true mule, but the foal which she suckles was not borne by her. This brings up for consideration the phenomenon of lactation among female mules. Concerning this phase of the question there is little or no debate. Anyone long in a mule country will have seen cases of true lactation in mules. To be sure the mammary tissue is normally activated by conception, but on the other hand every dairy cattle breeder has seen lactation induced in young virgin heifers by constant suckling of a "poorly weaned" calf, and even males have been known to be stimulated to secrete milk. It is not difficult to suppose, for the few cases demanding it, a set of circumstances which would enable a female mule with maternal characteristics to develop active milk secretion at a time opportune for stealing and

fostering a foal born of a mare—perhaps one lacking maternal instincts. In herds of horses and mules it might easily happen that a milking mule should adopt an orphan colt and give every appearance of being the colt's true mother.

2. Facts from the second line of study, *i. e.*, examination of the cell processes going on within the testis, and of the nature of the seminal discharge, will now be considered. Cossar Ewart was among the first to subject the seminal fluid of equine hybrids to microscopic inspection. His hybrids were produced by use of a Burchell zebra male on pony mares.[1] The male "Zebroids" thus formed were unable to beget offspring in the many mares to which they were put, though, as is true of male mules produced in the ordinary way, their behavior gave every reason to suppose that they were breeders. In the discussion of his work, Ewart repeatedly mentions seeing incompletely formed spermatozoa which were "hardly at all motile due to the tail being only about twice as long as the head, while in the normal horse and zebra it is fully eight to ten times the length of the head." This seems like a case of arrested development. Ewart interpreted this lack of motility as evidence that these imperfect sperm cells were unable to make any headway against the outward currents which exist in the generative tract of the female. As a result they never reached the ovum, were of no use, and the zebroid was sterile.

Stephan in 1902 reported some studies on the structure of mule testes. Some of his material was taken from castration operations and some from animals which had died. His studies were histological rather than cytological. He reports an almost complete absence of seminiferous tubules, a great exaggeration of "parenchyma" tissue, and many other unusual features.

In 1905 appeared Iwanoff's "Untersuchungen über die Ursachen der Unfruchtbarkeit von Zebroiden."

In point of material his work is comparable with Ewart's, but in results it is different.

Iwanoff worked with two male zebroids, one 4 and one 5 years old. Microscopic examination of the seminal discharge showed complete lack of spermatozoa, but many round, hard, glancing, refractory, glass-like bodies were present. "In these cases one cannot speak of degenerate or undeveloped sperm cells. Ewart probably mistook the round glass-like bodies with Brownian movement for sperm cells. How Ewart's observation of a tail twice as long as the head, in the semen of his hybrid, is to be explained, I cannot say." Suchtet ('96), as the result of his work on mule testes, also concludes that the spermatozoids were replaced by "little round, brilliant, glassy bodies."

The presence of these round refractory bodies in the semen cannot be gainsaid, but it is questionable if they should be interpreted as "replacing" the spermatozoa. These bodies are probably merely masses of hard albumen, and not cellular bodies at all. Similar bodies may be seen in the semen of normal sheep, swine and rabbits, in which there is an abundance of live and perfect spermatozoa. After long standing these bodies seem to absorb moisture, increase in size, lose their refractory properties and disappear. It is possible that the testes of the mule play little or no part in furnishing the seminal discharge, but that it is secreted by the accessory glands of the generative tract.

DEGENERATIVE CHANGES

Iwanoff also made some observations on the histological structure of the testis of the mule. He found tubules of greatly reduced diameter, comparable to those seen in sexually immature stallions. He reports excessive numbers of Sertoli cells, many degenerative, as well as degenerative spermatogonia. He also notes the presence of white leucocytes within the tubules, which, to his mind, play a part in the degenerative processes going on there. These obser-

[1] For an account of the production of zebra hybrids see "The Grevy Zebra as a Domestic Animal," by George M. Rommell. *American Breeders' Magazine*, Vol. IV, No. 3, pp. 129–139, November, 1913.

vations are in line with those of Guyer ('00) on sterile hybrid pigeons. Iwanoff further reports abundant parenchyma and interstitial cells, and emphasizes the secretory nature of these tissues, holding them accountable for the secondary sex characters of the mules.

Whitehead ('08) also reports work on testis structure in mules. He found no secondary spermatocytes and no spermatozoa of any kind; interstitial cells were abundant and granular. Whitehead had examined the testes of cryptorchid horses and found them to be similar in structure to those of the mule. He puts the scrotal testis of the mule in the same category with the abdominal testis in cryptorchids of pure species. Sexual passion is quite apart from sexual fruitfulness, mules and cryptorchids exhibiting the former in marked degree. Like Iwanoff, Whitehead says that sexual passion is due to specific internal secretions of the interstitial cells. "They are the only cells which can elaborate it for the only other secretory cells are degenerate, while the interstitial cells are hypertrophied."[2]

The most recent, and detailed work on the structure of the mule testis is by Wodsedalek ('16). He has carefully followed the cell cycle in the mule testis, and, carrying out the suggestions of Guyer made for pigeons in 1900, has offered a specific explanation for the abnormalities seen in the testis, which result in sterility. Wodsedalek had previously reported ('14) thirty-eight as the chromosome number in the mare—each ovum carrying the haploid number nineteen. From his study the above author concludes that a plausible chromosome number for the jack (male ass) is much greater than the horse, namely sixty-five, each sperm carrying thirty-two or thirty-three. As a consequence the fertilized egg destined to produce a male mule shows fifty-one chromosomes, nineteen from the mare and thirty-two from the jack. (It is assumed that the female mule would show fifty-two.) Despite the great diversity in the nature and number of the chromosomes contributed by the ovum of the mare on the one hand, and sperm of the jack on the other, mitosis and cleavage processes are apparently undisturbed, for growth and development of the fetus and of the foal proceed normally.

CAUSE OF STERILITY

As far as can be seen there is nothing irregular in the growth or cell divisions of the mule till he reaches sexual maturity. Up to this time maternal and paternal chromosomes have lain side by side and carried on their customary functions. There has been no necessity for them to cooperate to any noticeable extent, each chromosome has divided at mitosis independent of the others, one-half going to each daughter cell. The real conflict ensues during the various stages of the primary spermatocyte. Normally at this stage there is a pairing and subsequent separation of homologous chromosomes from father and mother. In case of the mule, however, because the ovum and sperm contributed such unequal numbers of chromosomes, there are many chromosomes without a homologue with which to mate, and even in case of homologues the physiological incompatibility of the two plasms render the pairing difficult and incomplete, or prevents it entirely. "So great is this disturbance that the destruction of each cell is inevitable and no spermatozoa are produced, causing the hybrid to be sterile." It is plain that the evidence drawn from such studies makes the likelihood of these animals begetting offspring extremely small if not altogether negligible.

However, it would seem wise to be conservative and tolerant. Several cases have been reported where there is a regular and orderly disappearance of sperm-forming cells. For instance, Morgan has shown that in certain generations of Phylloxerans, in spermatogenesis, half the spermatids (those lacking the accessory chromosome) regularly degenerate. The disappearance of these cells is precise in nature, and occurs in an orderly fashion at a fixed stage in the cycle of divisions. Apparently, how-

[2] Miss Boring (*Biol. Bull.*, XXIII, pp. 141–153), working on the testis of the fowl, failed to find evidence in support of the view that interstitial tissue is responsible for secondary sex characters.

ever, the abnormalities seen in the cell divisions in the mule testis are not precise in nature, but occur in a haphazard fashion, as a result of a tangled confusion of cell elements—it is not inconceivable that a chance series of divisions might give rise to a germ cell able to cause conception in a fertile female.

Moreover, it must be noted that it is extremely seldom indeed that male mules are allowed to come to the age of maturity without castration, and it is even more seldom that they are allowed to breed mares. Therefore there is very slight opportunity to put their breeding powers to a test.

It should be further remembered that in practically every case these microscopic studies have been made on the germ gland of the male. It is conceivable that matters might occasionally proceed differently in the ovary, where a different chromosome constellation exists. This would result in a condition where female mules might at rare intervals possess generative powers but males never.

There may be some uses for which a mule that is only ¼ horse might prove valuable, and certain it is that there are many occasions where a mule that is only ¼ ass would be welcomed with relief and joy. But such animals are not as yet staple market commodities, for whatever the true situation in regard to mules occasionally producing offspring may be, one thing remains certain, namely, that as far as the breeding industry is concerned, we must as yet take our mules half-and-half in the way that Homer and Varro described several thousand years ago.

LIST OF REFERENCES

AYRAULT, EUGENE.—De l'Industrie Mulassière.

EWART, COSSAR.—1899. Penycuick Experiments.

GUYER, M. F.—1900. Spermatogenesis of Normal and Hybrid Pigeons. Univ. Cincinnati, Bulletin 22.

IWANOFF, E.—1915. Untersuchungen über die Ursachen der Unfruchtbarkeit von Zebroiden. Biol. Cent. 25: 789–804.

SANSON, ANDRÉ.—1888. Traité de Zoötechnie, Tomes 3–5.

SHAILER, N. S.—1895. Domesticated Animals.

STEPHAN.—1902. Sur la structure histologique du testicule des Mulets. C. R. d l'Assoc. d'Anat. IV, Montpellier (quoted by Iwanoff).

TEGETMEIER, W. B. and SUTHERLAND, C. L.—1895. Horses, Asses, Zebras, Mules and Mule Breeding. London.

WHITEHEAD, R. H.—1908. Function of Interstitial Cells of Testes. Anat. Rec. 2:177.

WODSEDALEK, J. E.—1916. Causes of Sterility in the Mule. Biol. Bulletin XXX: 40, pls. i–ix.

IRIS BREEDING

IRISES have been little used by students of genetics, probably because other plants can be grown in less space and time. Pollinations are easily made, however, and any amateur of this genus might well try his hand at crossing some of his favorite forms. Miss Grace Sturtevant of Wellesley Farms, Mass., contributes the following suggestions of technique:

"The irises with which I have worked have been the hardy varieties which could be grown without protection or especial treatment in my garden; thus limiting the scope of the crossing in a large degree to what are known as German irises, though truth to tell I have yet to obtain a seed from a real German iris.

"The method of procedure is simple. I remove the stamens from the bloom to be cross-fertilized, before the pollen sacs open, and apply pollen to the lip of the stigma by rubbing it with a pollen-laden anther from the bloom used in making the cross. This covers the surface with pollen so well that there is little danger from other pollen, but to make matters sure the bloom can be protected for a short time, or the falls removed so that no wandering bee can crawl in beneath the arching style-arm. I usually remove the rest of the buds on that branch and label it.

"On ripening, the seeds are removed from the pod, described, recorded and dried. I have the seed-bed prepared quite a time in advance so as to have it moderately firm; a plan is made, and the seed is planted about half an inch deep; the result of each cross in its respective square; and a square of wire mosquito netting is pinned down over it to protect it from accidental disturbances by birds or animals, as this is in August and the seed does not germinate, as a rule, before the following April. When about an inch high they are transplanted to a bed for seedlings, being placed one foot apart in the lines. Each is recorded on the plan of this bed and here they remain until they bloom. They require little attention (weeding and a few inches of leaves for covering in the fall) until the following year when many will bloom and the descriptions have to be written and records completed.

"Fortunately any gaps in these descriptions may be filled, or additional information as to interesting points may be obtained, in subsequent years. Comparison can also be made with the parents, or offspring, when plants are mature, as records are kept of their permanent positions.

"Although I have not grown enough generations to be able to foretell results, I have obtained some unique individuals; some as good as or better than their parents; and many similar to the well-known garden forms."

Miss Sturtevant's irises show abundant evidence of segregation of characters, and it is therefore fair to suppose that Mendelian heredity would be found in the German irises, if they were properly studied. Such does not seem to be the case in hybrids between wholly distinct species, however.

For many years it has been an open question whether the Mendelian type of heredity applied to crosses between distinct species, or only to crosses within a species, or between hybrid forms. To throw light on this point, W. R. Dykes made a number of hybridizations, and describes the result in the Gardeners' Chronicle of London (Vol. LVIII, pp. 196–197). With numerous pairs of characters, the results showed no dominance but only blending.

Iris boissieri, bulbous, with the beard of the sepals in the form of long straggling golden hairs 0.117 to 0.234 inch in length, crossed with *I. tingitana* having no trace of hair gave a hybrid with hair distinctly visible to the naked eye but less than 0.0585 inch in length.

I. tectorum (which has a tuft in place of hair) crossed with *I. cengialtii* (a hairy type) gave a hybrid with a light violet coloured tuft bearing a short hair.

I. xiphium (without perianth tube) crossed with *I. tingitana* and *I. filifolia* (having perianth tubes 0.975 and 0.507 inch, respectively) gave hybrids with perianth tubes respectively 0.507 and 0.234 inch long.

I. clarkei with solid stems crossed with *I. chrysographes* with the internal cavity of the stem occupying about half the diameter, gave a hybrid intermediate with central hollow almost but not entirely closed with pith.

I. pallida with papery spathes which become entirely white and dry before protruding from the floral opening, crossed with *I. variegata* with green and herbaceous spathes gave a hybrid with spathes green in the lower portion and parchment-like in the upper portion.

The hybrid between *I. reticulata* and *I. bakeriana* is intermediate between the parents as regards leaf shape.

Also with regard to the coloring of the petals many hybrids are intermediate between the parents of various species, *e. g.*, *I. pallida* × *I. variegata; I. trojan*×*I. variegata; I. boissieri* ×*I. juncea; I. fulva* × *I. foliosa; I. forresti* × *I. sibirica.*

With the exception of *I. chrysographes* × *I. forrestii* and also possibly of *I. pallida*×*I. variegata* and of *I. fulva*×*I. foliosa* all the above hybrids were sterile both with respect to their own pollen and that of both parents. The two possible exceptions are cases in which the parents are somewhat related whilst the fertile hybrid has more definitely related parents.

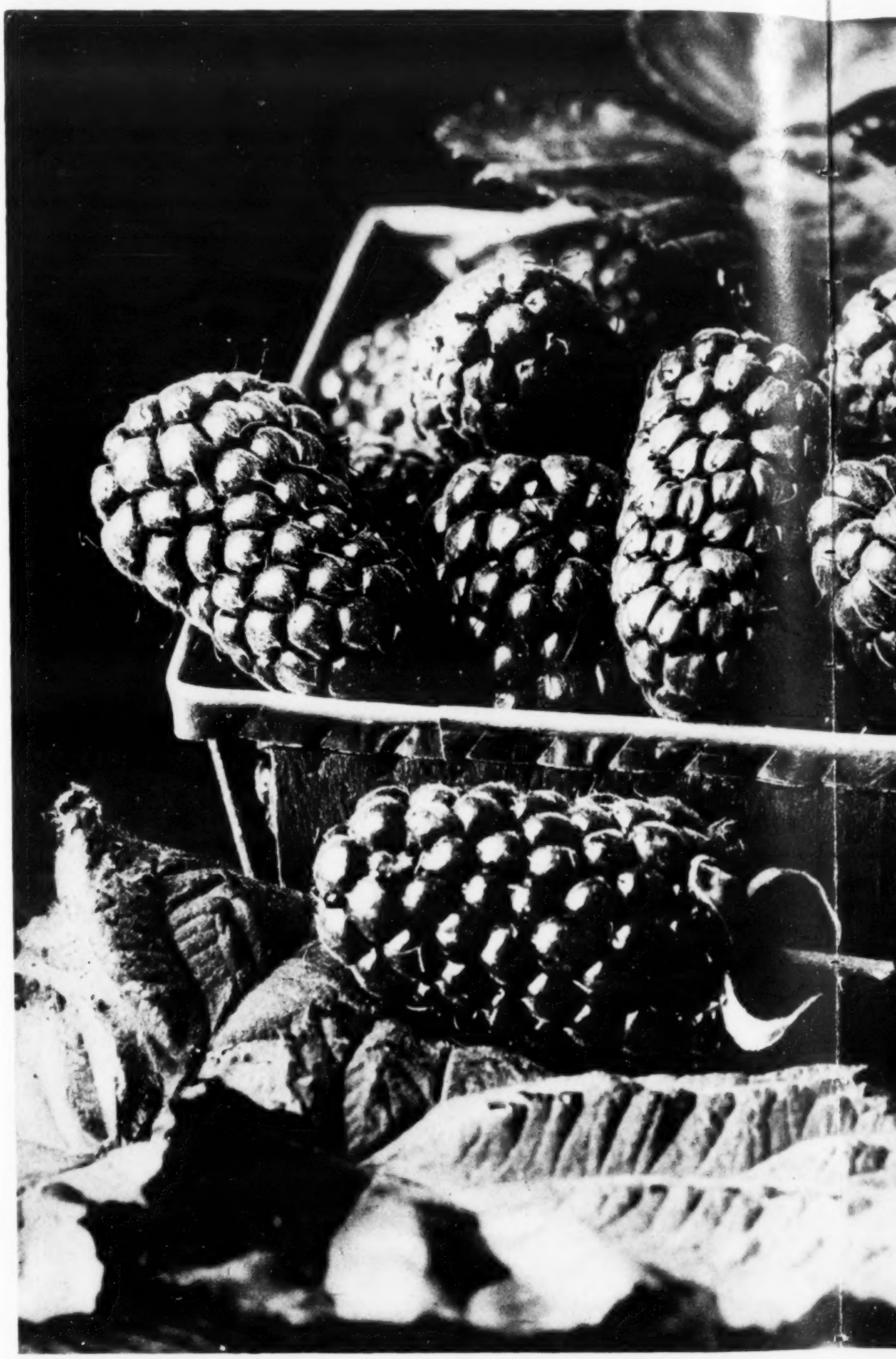
Another interesting species-cross, which to some extent confirms the above conclusions, is reported by S. Mottet in the *Revue Horticole* of Paris (87, pp. 582–583). *Iris pumila*, a species which flowers early (beginning to end of April) with *I. germanica*, of which the earliest flowers appear about the middle of May, yielded numerous varieties flowering in the first half of May, thus enabling growers to have a continuous supply of iris for about three months. Mottet has given the new forms the horticultural name of *Iris interregna* and describes them as intermediate between the two parent species not only in date of flowering but for height, leaves and dimensions of the flowers. Miss Sturtevant adds that interregna flowers are often larger than those of either parent.

IS THE HYBRID ORIGIN OF TH

THE Loganberry, one of the most popular members of the genus Rubus, came to light about 1881, in the grounds of Judge J. H. Logan of Santa Cruz, Cal. It was described by him as a natural hybrid which appeared spontaneously, and he believed that the parents were the Aughinbaugh (a variety of *Rubus vitifolius*, the wild blackberry of California) and a red raspberry, probably the variety Red Antwerp, since these two were growing near together in his yard. The fruit of the Loganberry is, in many respects, intermediate between the blackberry and red raspberry, and Judge Logan's account of its origin was accepted as probable. It has since then been universally described as a chance natural hybrid.

In later years, numerous artificial hybrids between blackberries and red raspberries were secured, Primus and Phenomenal being the best known ones. These were in many respects similar to the Loganberry, and supported a belief that the latter was a hybrid of similar nature.

But evidence which is now accumulating indicates that this belief is wrong. The question is squarely put by W. O. Backhouse, Economic Botanist to the Argentine Government, who writes to this association from Buenos Aires under date of July 4, 1916, as follows:



A BOX OF LOGANBERRIES.

Although its flavor is too acid for some palates, the Loganberry has c
and raspberry genus. Unfortunately it can only be grown in a lim
this area it is so much in demand that many growers have contrac
taken by canners. The Loganberry has hitherto been described
Argentine Government, declares this is a mistake, and North Ame
from the Fancher Creek Nurseries, Fresno, Cal. (Fig. 10.)

MR. BACKHOUSE'S WORK

"In a footnote to the article of Miss L. M. Standish, on Crataegus (JOURNAL OF HEREDITY, June, 1916), it is stated that the evidence as to whether the Loganberry breeds true is conflicting. The material at the disposal of the present writer is somewhat scattered and not enough to form the basis of a serious scientific contribution, nevertheless the following observations may shed some light upon the subject whether the Loganberry is a hybrid at all.

"The writer has raised Loganberry from seed in some quantity; so also have

THE LOGANBERRY A MYTH?

ERRIES, NATURAL SIZE

rry has come to be considered one of the best fruits of the blackberry
n in a limited area of the United States, where there is little frost. In
e contracted for the sale of their fruit five years ahead, most of it being
described as a natural hybrid, but W. O. Backhouse, botanist of the
orth American students seem inclined to agree with him. Photograph
0.)

Messrs. Laxton Bros., of Bedford, England, whose plants he has had the pleasure of inspecting. To say that the Loganberry breeds true is not strictly correct, nor is it correct to say that any real gametic splitting takes place. The plants are nearly all different one from another, but the differences are in minor characters, such as the length of the fruit, the amount of spines on the petiole and leaf and the color of the leaves. From an economic standpoint some are decidedly better than others; but there is no suggestion of either blackberry or raspberry.

"Supposing that the Loganberry were a hybrid, but that it reproduced itself asexually, after the manner of many plants, through the seeds, then one would not expect any variation at all, but all the seedlings should resemble the parent and one another. To test this, crosses were made with other species of the same genus.[1] If the foreign pollen should act simply as a stimulus to make the plant reproduce itself asexually we should expect that there would result Loganberries, exactly like the parent; if proper fertilization should take place we should expect a great diversity of forms, corresponding to the segregation of the various characters in the supposed hybrid, Loganberry.

"What actually happened was that the hybrids were remarkably constant, giving forms which were, looked upon broadly, intermediate between the Loganberry and the other parent chosen. Hybrids between Loganberry and raspberry gave a first generation varying in fertility between almost complete sterility and setting a dozen or so drupels on a fruit; but in vegetative characters remarkably constant and roughly speaking intermediate between the two parents.

"Reciprocal crosses have been made by Messrs. Laxton Bros. with other species, all giving hybrids more or less sterile, but uniform, in each case and

showing nothing to lead one to suppose that the Loganberry was other than a good species.

"Finally, in 1910, the writer succeeded in obtaining a hybrid between the Loganberry and the common English blackberry, *Rubus ulmaefolius*. This proved to be the most fertile of all the hybrids made, setting almost complete fruits when left to natural pollinating agencies and setting fairly well when isolated. The F_1 is, again, more or less intermediate. The down on the fruit is a clean dominant, coming from the Loganberry; the taste is a peculiar mixture of Loganberry and blackberry—it is interesting to note here that the flavor of the Loganberry, which was regarded as a hybrid flavor, is almost a dominant. The color of the fruit is almost black and the shape not quite so long as that of the Loganberry.

"A second generation of this cross has been grown in Buenos Aires giving the very segregation expected, namely, an almost imperceptible gradation between plants which would pass for *Rubus ulmaefolius*, and others which would almost pass for Loganberry. Here again it must be noted that there are no plants which approach the raspberry. Unfortunately, all which have fruited so far have been nearly sterile. This is probably because, in the hot, dry summer of Buenos Aires, *Rubus ulmaefolius* does not fruit.

"From these scattered observations it will be seen that the Loganberry has behaved throughout as a good species, neither breeding perfectly true from seed, nor yet showing more variation than was to be expected in a species. Used either as a seed parent, or a pollen parent, it gave, when crossed with wild species, very uniform hybrids, and some variation when used with cultivated varieties, which are not genetically pure.

"It therefore seems that, unless we can conceive of a hybrid which has resulted gametically pure in the first generation, we must reject the commonly accepted idea of the origin of the Loganberry."

The fact that the Loganberry sometimes, at least, breeds true from seed has been long known. Dr. L. Trabut, botanist of the Government of Algeria, stated to the writer in 1913 that he had been growing it from American seed and that it came true. Similar results have been secured on the Pacific coast; at other times, considerable variation has been observed, although the writer has seen no record of any such amount of variation as would be expected of a hybrid in its F_2 generation.

In order to get the opinions of some American students of the genus Rubus, the editor wrote to U. P. Hedrick, of the New York (Geneva) experiment station, and to C. I. Lewis, of the Oregon experiment station. Mr. Hedrick replied that he had had no personal experience with the Loganberry but that a number of things had recently led him to suspect that it is not a hybrid, but a true species.

Mr. Lewis wrote that he was undertaking an extensive experimental test and in advance of the completion of this could not make a full statement. He expressed his own belief, which he said was now that of most of the workers on the Pacific coast, that the commonly accepted story of the hybrid origin of the Loganberry is not correct, but that it is a true species, as good as plenty of other species in the genus Rubus which, as is well known, is much confused and, due to natural hybridity or some other cause, is highly variable.

If the Loganberry is a good species, it must have a habitat somewhere, aside from Judge Logan's back yard. Why is it that it has never been reported elsewhere?

Mr. Lewis thinks it has been reported, and that there are records of its sporadic occurrence in various parts of California, Oregon and Washington. It may be a species of comparatively recent origin, as its variability suggests. The Oregon station is gathering a collection, and will undertake by breeding to arrive at the real origin of the Loganberry. Evidence will probably be available within a few years, and it looks now as if this evidence would pretty definitely destroy the present belief in the natural cross between a blackberry and red raspberry. It is more probable, as

Mr. Lewis says, that the Loganberry is a dewberry type and a distinct species in itself.

Mr. Lewis was particularly asked about his statement (in Bailey's Standard Cyclopedia of Horticulture) that Loganberry seedlings showed much variation. "What I meant by that," he replies,[2] "was that they vary more than the seedlings of the raspberry."

MUCH CROSSING PROBABLE

"You go into almost any Loganberry patch of any size here in the Northwest," he continues, "and you will find that there is some variation. Perhaps you will find a plant with the Loganberry leaves, but the fruit will be more like the blackberry. . . . It is not uncommon to go into a single half acre of ground and find the cultivated dewberry, the wild native dewberry, the Himalaya, the Evergreen, and perhaps a standard blackberry, such as the Snyder, all growing side by side, and in addition to this, raspberries, perhaps Phenomenal, and others. Now you have there ideal opportunities for crossing, and with a form like the Loganberry, which is perhaps not as entirely fixed as the older forms, I would look for considerable hybridizing to take place."

J. A. Brixby, a nurseryman at McMinnville, "has a very fine collection of Loganberries. He says his seedlings were simply gathered at random but were gathered in a patch where there was quite a wide planting of small fruits, so that probably there were ideal conditions for cross-pollination. His Loganberries show quite a variation in foliage and he tells me that there is a great range in time of ripening and also in acidity, and some change of form."

"Prof. Gardner at one time visited Vancouver Island and while there met a nurseryman in the north end of the island. This man said the Loganberry grew wild in certain portions of Vancouver Island and that he had been in the habit for many years of going to the woods and digging up plants to fill orders whenever his stock was depleted, and he could not see that there was any difference in the wild plants from those he propagated himself. Here in Oregon wild plants of the Loganberry type are found. There are two such plants near Corvallis. . . . I have come across one plant, the owner of which tells me that one half is like the true Loganberry and the other half more like the fruit of the blackberry."

It is evident, then, that American students have been gradually accumulating data which tended to cast a doubt on the paternity of the Loganberry; but the Argentine botanist appears to be entitled to credit as the first man publicly to challenge it. In a genus so confused as Rubus, it may prove difficult to establish the exact origin of the Loganberry, but the evidence now at hand seems to be enough to class as a myth the accepted story that its sole origin was as a spontaneous hybrid in Santa Cruz.

Heredity in Pellagra

The Eugenics Record Office announces the forthcoming publication of Bulletin No. 16 on Pellagra, by C. B. Davenport and Elizabeth B. Muncey. Dr. Muncey worked on the subject in Spartanburg County, S. C., and concludes that "the data collected show no evidence of direct heredity. There may, however, be an inherited predisposition to the disease in those families in which chronic gastro-intestinal symptoms have existed for several generations. With this predisposition to the disease direct contact or life in endemic sections might be the exciting factor necessary for its development."

---

[1] Mr. Backhouse writes: "I have not defined the different species used in making hybrids with the Loganberry, in my own work, because I am not absolutely sure of the nomenclature; I have no means of verifying it here and do not want to lead people astray; and I cannot divulge those used by Laxton Bros. because they are in the nature of commercial secrets. This, however, does not in any way affect the substance of the communication, the point being that whatever species was used, each gave its own *uniform* batch of hybrids, which is not at all in keeping with the Loganberry's supposed origin."

[2] In a letter dated August 17, 1916.

LOBED LEAVES IN MAIZE

Two Edges of Leaf Cut Each Other When Growing—Resultant Clefts Were Supposed by Blaringhem to be Due to Inheritance of a Mutilation

J. H. KEMPTON

Bureau of Plant Industry, Washington, D. C.

IN 1911 there appeared in an early variety of maize from Russia what was thought to be a new abnormality. This was a pronounced lobing of the leaves on many of the plants, and as none of the grasses normally has lobed leaves, this character received careful attention.

As the season progressed, the abnormality was found in varying degrees on all of ninety varieties planted that season at Lanham, Md. The conspicuous nature of the lobes led to the belief that this must be their first appearance. This view was quickly dispelled when upon examining commercial plantings of local varieties many of the plants were found to have lobed leaves. In following seasons lobes recurred not only in Maryland, but in many other localities where opportunity for examination was presented. They were also found on plants of Euchlaena, Coix, Tripsacum and various members of the Andropogoneæ, and doubtless occur on many other grasses.

The superficial resemblance of lobes to torn leaves must account for the fact that they had escaped detection in previous years. Careful observation, however, reveals pronounced differences between lobed and split leaves, and once these are recognized, there can be no confusion of the two forms of injury.

The lobes are usually paired, one on each side of the leaf and nearly opposite. This is not always the case, however, as several leaves with only one lobe have been found and a few with as many as six lobes.

The most constant characteristics of true lobes are the margins, which are transparent like those of a normal leaf, and are beset with long brittle hairs and a double row of short saw-like teeth directed toward the apex of the leaf. The edges of torn leaves lack these teeth and the marginal cells are dead. Lobes are also sometimes spatulate in form, with the margin at the base of the split thickened and rounded.

The veins frequently divide a short distance below the split, one branch continuing to the main blade, the other to the lobe. The veins that do not divide alter their course below the split, making a curve which enables them to reach the lobe. The presence of normal marginal tissue, together with the blunt or spatulate form of many of the lobes, indicates that the formation of the lobes takes place at a very early stage in the development of the leaf.

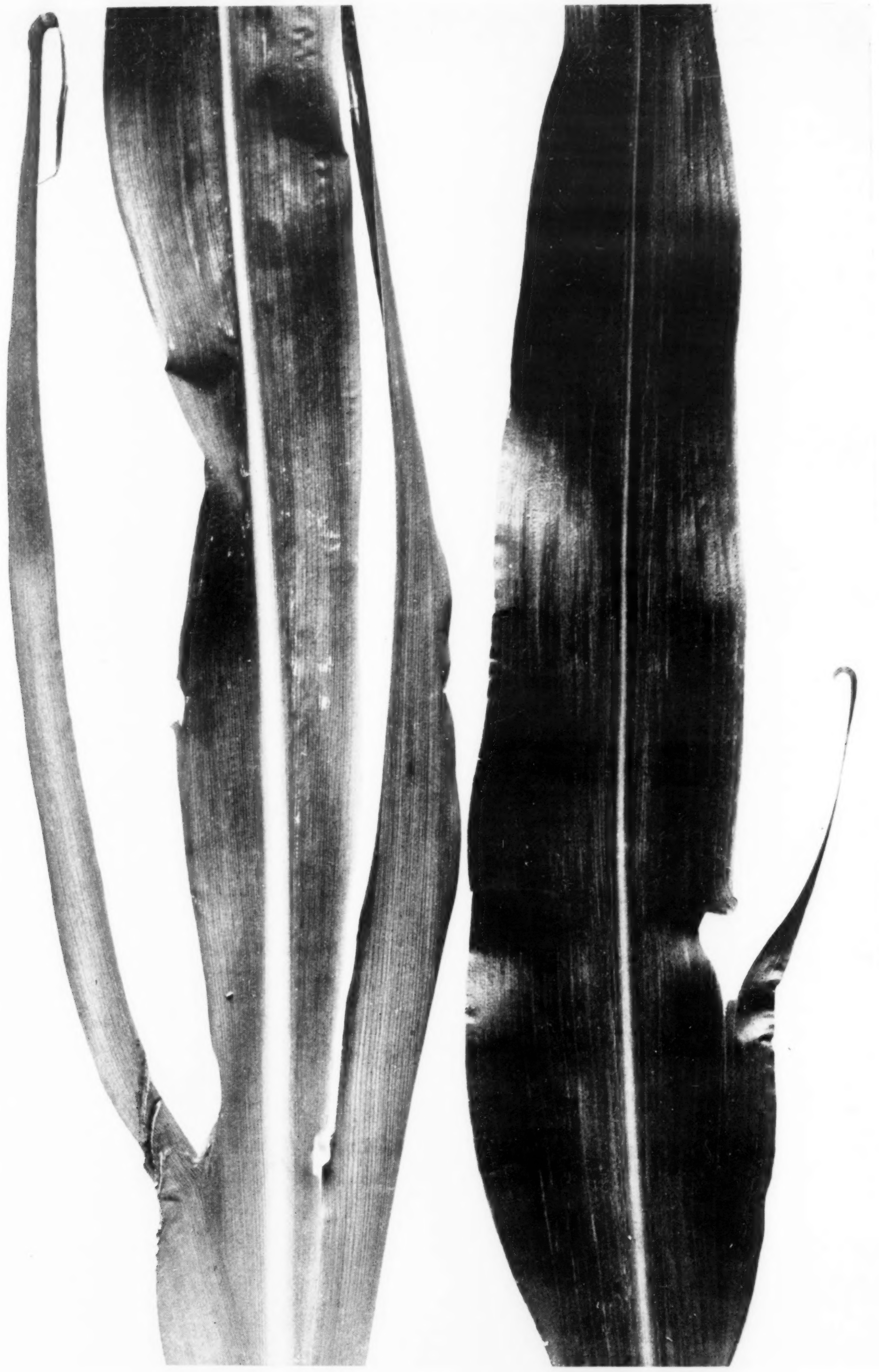
The lobing often results in a complete entanglement of the leaves, so that the plant is prevented from growing in a normal manner and in extreme cases the upper leaves and tassel never emerge. Plants thus affected have a characteristic "bent over" shape.

LOBING OF OTHER ORGANS

The occurrence of lobing is not confined to the leaf blades of the main culm and tillers, but has also been frequently observed on other homologous organs of the plant. The most common among these are the husks, husk leaves, and the glumes of the tassel. In this latter case the lobes are very small, but are undoubtedly of the same nature as those on the leaf blades.

A slightly modified type of lobing is also found on prophylla. The abnormality in this case could hardly be called lobing, but is in reality notching. These notches are in pairs on opposite sides of the prophylla, much the same as the lobes on the blades.

Lobes approximating in shape those



THE "LOBES" OF MAIZE LEAVES

The edges of the leaf sometimes cut each other as they grow, thus producing this deceptive appearance of lobing. The veins of the leaf rearrange themselves, as may be seen in the lower left-hand corner of the picture, to conform to the changed condition of affairs. This abnormality is not very rare, although it has seldom been noticed. Blaringhem, who mutilated maize plants to see if he could produce an inherited effect, found these "lobes" in the progeny, and wrongly supposed that they were due to his manipulations. Photograph natural size. (Fig. 11.)

on the leaves are occasionally found on the keels of prophylla, though they are usually small and poorly formed.

It was at first thought that the lobing of the leaves was a purely local abnormality directly due to some climatic disturbance much as is the leaf cut or Tomosis of Cotton. However, the observations of Blaringhem in France and Gernert in Illinois demonstrate beyond doubt that forms of lobing have a wide distribution.[1] Investigation also shows that lobing not only occurs on experimental varieties outside their natural environment, but is found in about the same percentage in commercial plantings in many localities.

The cause of the lobing was not fully understood until in dissecting some very small lateral branches of Euchlaena it was noticed that several of the shoots were prevented from unfurling by having the margins of one of the leaf blades firmly held together with lobes. By examining still smaller shoots, the stage was finally reached where the lobes were just being formed. These shoots were about 6 cm. long and the tissue was exceedingly tender. It was at once seen that the lobes were formed by the margins of the leaf blades cutting each other where they crossed in unfurling.

The forcing of the inside margin of the leaf against the outside margin results in the inside margin being cut, but at the same time the outside margin also receives a slight cut through which the lobe on the inside margin grows. As this lobe grows it cuts upward into the outside margin which accounts for the small back cut sometimes found on one margin of the more perfect specimens. A slight rupture of the tissue, which at this young stage is extremely tender, results in the separated cells developing practically independent of the remainder of the leaf blade.

The fact that the two margins of the same leaf mutually rupture each other accounts for the lobes being most often found in pairs one on each side of the leaf.

Lobes are not always made by the margins of the same leaf, but are sometimes made by the margins of adjoining leaves. In this way a single lobe on only one side of the leaf is brought about. Frequently when the margin of a leaf comes in contact with another leaf immediately inside of it the result is an opening in the leaf which develops marginal tissue on each edge. The marginal teeth, if examined at an early stage, are seen to be about half the size of the teeth on the outside margins of the blade.

The comparatively late stage in the development of the leaf at which lobing takes place, demonstrates that the cells normally forming the body of the leaf blade are capable of being transformed into the specialized marginal tissue.

Mutations in the Potato

It has sometimes been alleged that the characters of wild species of potato are immutable, but J. Aumiot, who has been breeding many of them, reports changes of many kinds, in *C. R. Acad. Agric.*, November, 1915, summarized in the *International Review of Agriculture*. Aside from changes of simple characters like color, there were supposed mutations which affected the time of maturity, the character of the skin, the growth habit, and the flowers. In one instance a plant of *Solanum commersoni* is alleged to have been transformed so that it closely resembled a cultivated variety. The study of such cases as this might throw much light on the process of evolution.

---

[1] The first notice of these lobed leaves which I have found is by L. Blaringhem in *Mutation et Traumatismes* (Paris, 1908). Blaringhem mutilated maize plants in various ways and then grew their seed; the resulting plants showed various abnormalities, such as cleft leaves, which he thought were due to his mutilation of the parents. When other observers discovered the same abnormalities in maize plants whose parents had not been mutilated, Blaringhem's effort to revive the inheritance of acquired characters came to nothing. Since then Gernert mentioned lobed or cleft leaves as one of the many abnormalities to be found in maize, but gave no explanation of their origin. ("The Analysis of Characters in Corn and their Behavior in Transmission," p. 25, Champaign, Ill., 1912.)

HAND AND FOOT PRINTS

Corrugated Skin of Palm and Sole Furnishes Many Interesting Problems—Limits of Heredity in Finger-Print Patterns—The Friction-Skin Patterns of Monkeys and Apes

FINGER-PRINTS are naturally associated in one's mind with criminals; but the possession of a complicated pattern on the "friction-skin" of the hands and feet is by no means confined to the ladies and gentlemen of the Rogues' Gallery. Not only do all human beings possess such friction-skin, but the anthropoid apes have quite similar patterns, which can be followed down to their rudiments in the lower monkeys, and traced in many other animals.

Certainly those geneticists who announce the futility of looking for a "purpose" in anything save themselves a lot of trouble; for a long debate has been carried on over the possible use of these palm and sole patterns. Galton tells[1] a good story of Herbert Spencer in this connection.

"An amusing instance of his strong leaning to *a priori* reasoning rather than to experiment occurred on his coming to a laboratory I had then established for anthropological purposes. I told Spencer of the difficulty of accounting for the peculiarities in the pattern of finger-prints, and that the dissection of embryos had thus far told no more than that they could be referred to folds of membrane in which the sudorific glands were formed, but threw no light on the reason why the pattern should here be a whorl and there a loop and so on. He said that dissection was not the best way to find out what I wanted to know; I ought to have started from a consideration of the use of the ridges, and he proceeded to elaborate a line of argument with great fulness in his usual sententious way. It was to the effect that the mouths of the ducts, being delicate and liable to injury from abrasion, required the shield of ridges, and on this basis he reared a wonderfully ingenious and complicated superstructure of imaginary results to which I listened with infinite inward amusement. When he had quite concluded, I replied with much humility, that his arguments were most beautiful and cogent and fully deserved to be true, but unfortunately the ducts did *not* open out in the shielded valleys, but along the exposed crests of the ridges. He burst out with a good-humored laugh, and then told me the story, which also appears in his Autobiography, of Huxley's saying that if Spencer ever wrote a tragedy, the plot would be the slaying of a beautiful induction by an ugly fact."

ORIGIN OF THE RIDGES

Later students, while proceeding from sounder premises than Spencer, have been equally obliged to depend on speculation. Miss Whipple, who studied the genesis of the ridges which characterize friction-skin in various orders of mammals, showed[2] that "they are formed from either (1) the coalescence of separate *epidermic units*, each with a sweat gland (and typically, a sebaceous gland and a hair) which arrange themselves in rows and form single ridges; or in other cases from (2) *epidermic rings*, formed by a coalescence of the primary units in circles, which, by becoming elliptical and arranging themselves in rows corresponding to their longitudinal axes, form simultaneously two rows of ridges."

It is now affirmed that the sweat glands open on the crests of the ridges in order that their openings may not be clogged up. As to the function of

[1] In Duncan's biography of Spencer (New York, 1908), Vol. ii, pp. 263–264.

[2] Zeitschrift f. Morphologie u. Anthropologie, Band vii, pp. 261–368. Miss Whipple later became Mrs. Harris H. Wilder.

A HUMAN FINGER-TIP

The palms of the hands and soles of the feet are covered with little ridges or corrugations, which are supposed to be useful in preventing the grasp from slipping; whence the name of friction-skin has been given to these surfaces. The ridges are developed into various patterns; the one above is a loop on the left forefinger. The ridges are studded with the openings of the sweat glands, the elevated position of which is supposed to prevent them from being clogged up; further, the moisture which they secrete perhaps adds to the friction of the skin. Photograph by John Howard Payne. (Fig. 12.)

the ridges themselves, it is suggested that they serve at least two purposes: to give increased delicacy to the sense of touch, and to furnish a surface which will prevent slipping.

Walter Kidd,[3] the chief defender of the tactile theory, points out that if friction were the only use of this corrugated skin, it would hardly be necessary on the sole of man's foot; since prior to the time when he wore shoes his feet were planted on grass and rocks where the slight friction offered would be of little value. He thinks that the pattern on the sole rather increases the tactile sensibility of that region, and aids a man in keeping his balance when he walks. But such theories are not very convincing, particularly as man may be supposed to have inherited his sole-pattern from ape-like ancestors whose feet were adapted to clinging to the boughs of trees.

The idea that this skin is, as Wilder

[3] The Sense of Touch in Mammals and Birds. London, 1907. Galton also accepted this theory, to some extent. It is true that the finger tips are especially sensitive, but the nature of relation between this sensitiveness and the ridges is not proved. The skin is a mosaic of tiny sensorial areas, touch spots, cold spots, warm spots and pain spots being widely and irregularly distributed. On the finger tips the touch corpuscles are frequent—about twenty-one per square centimeter on the index finger, while there are only two to eight per square centimeter on other parts of palm and on the sole.

SIXTY-FIVE POINTS OF IDENTIFICATION

Print of a finger-tip showing a loop-pattern, enlarged about eight times. This is a common type of pattern, and at first glance the reader may think it could be mistaken for one of his own. There are, however, at least sixty-five "ridge characteristics" on the above print, which an expert would recognize and would use for the purpose of identification. If it were found that the first two or three of them noted corresponded to similar characteristics on another print, the expert would have no doubt that the two prints were made by the same finger. In police bureaus, finger-prints are filed for reference with a classification based on the type of pattern, number of ridges between two given points, etc; and a simple formula results which makes it easy to find all prints which bear a general resemblance to each other. The exact identity or lack of it is then determined by a comparison of such *minutiae* as the sixty-five above enumerated. While the general outline of a pattern is inherited, these small characters do not seem to be, but are apparently rather due to the stretching of the skin as it grows. Illustration from J. H. Taylor. (Fig. 13.)

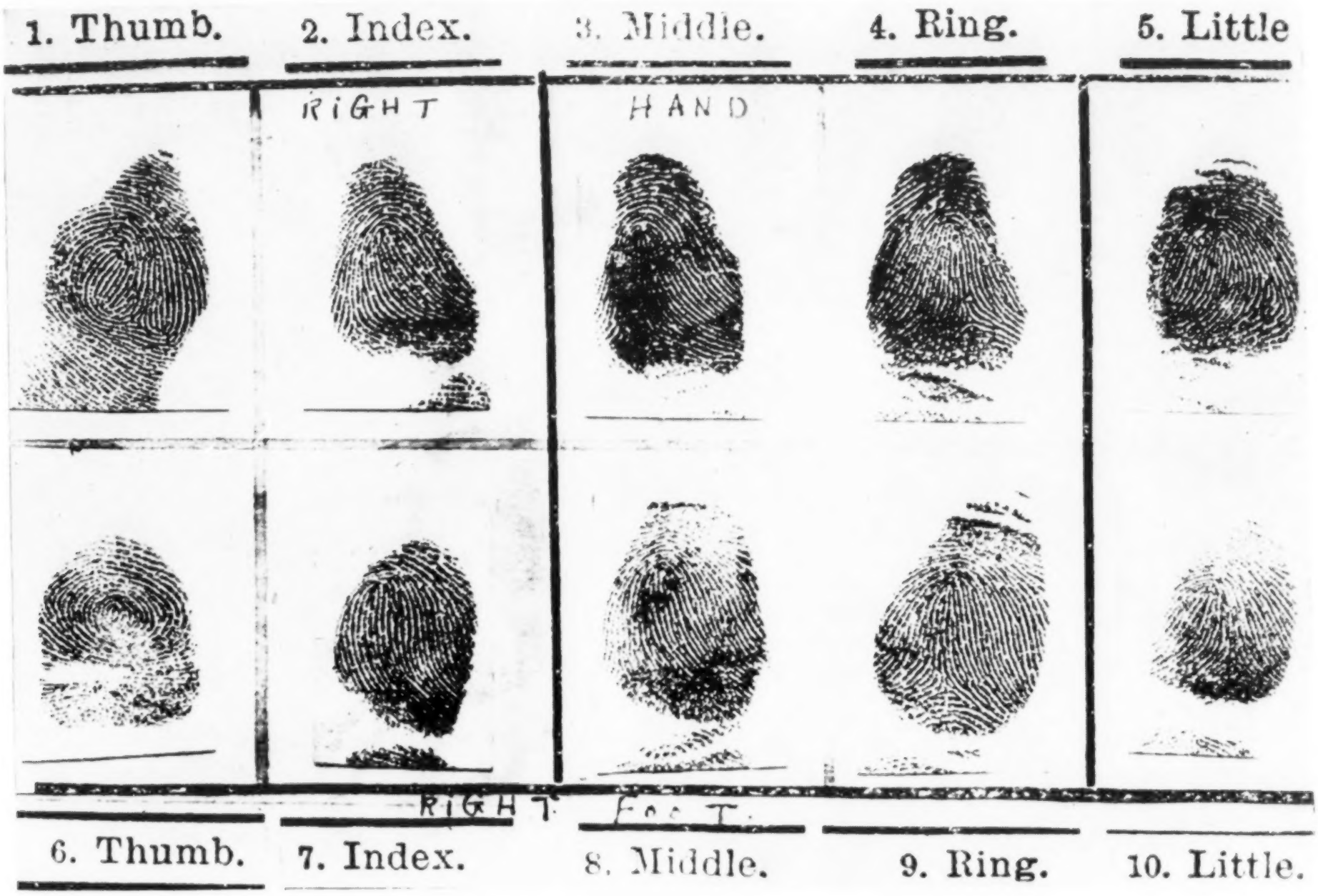
and Miss Whipple named it, really a friction-skin is much more plausible. Says Lydekker:[4]

"The best clue to the problem seems to be afforded, somewhat strangely, by the tails of such South American monkeys as are endowed with prehensile power in those appendages; confirmatory evidence being afforded by the prehensile tails of the American opossums and tree-porcupines, as well as by those of the Australian phalangers. In all these animals the naked, grasping portion of the tail, which is situated at the extremity, is covered with papillary ridges and grooves precisely similar to those on the hands and feet of monkeys, but invariably arranged in

[4] Mostly Mammals, by R. Lydekker. London, 1903, pp. 145–155.

RIGHT FOOT OF A LEMUR

In this low form of monkey the friction-skin is well developed, but the patterns which characterize the higher apes and man have not yet appeared. In the place of the well-known loops, arches and whorls, the lemur's finger-tips are seen to be marked only by longitudinal ridges. Photograph by Gertrude Sullender. (Fig. 14.)



FINGER AND TOE PRINTS OF AN ORANG OUTANG

If the reader will compare these prints with the tips of his own fingers, he will see that they are not very dissimilar; he will also find on inspection, what he has possibly never before noticed, that his own toes have equally distinct and well-marked patterns. Most of the patterns are common both to man and his humble kin, and no one but an expert, seeing one of the above prints, could declare that it had not been made by a human being. The study of friction-skin furnishes, among other things, good evidence in support of the doctrine of evolution. Photograph by Gertrude M. Sullender. (Fig. 15.)

simple transverse lines around the tail, so that in the act of grasping they would be parallel to the long axis of the branch around which the tail was coiled. Clearly, then, papillary ridges are primarily connected with the grasping power, and when they are intended solely for that function, they are so arranged as to be parallel to the axis of the object grasped. As regards this function of the papillary ridges, Dr. Hepburn observes that, although they are comparatively low, 'yet they must cause a certain amount of friction, and thereby prevent slipping, while the naturally moist and clammy condition of the palm and sole of monkeys must be of material assistance to the firmness of the grasp. A man instinctively moistens the palms of his hands when he wishes to make his grasp more secure; and the grasping power of monkeys must be considerably increased by the application of the numerous papillary ridges which are capable of intimate adaptation to the surface of the object grasped.' "

DARWINIAN SPECULATIONS

One may admit that a fully developed friction-skin may be useful, and yet refuse to believe that its origin is due to natural selection. We are asked to believe that the monkey in whose palms a slight transverse corrugation appeared would be less likely to slip from the limb and fall into the jaws of the waiting carnivore below; we are also asked, in explanation of longitudinal ridges in the hand, to believe that a fruit would less often slip from the hand of the monkey in which these first appeared, and therefore he would be the venerable sire of a well-endowed progeny, when

A GORILLA FINGER-PRINT

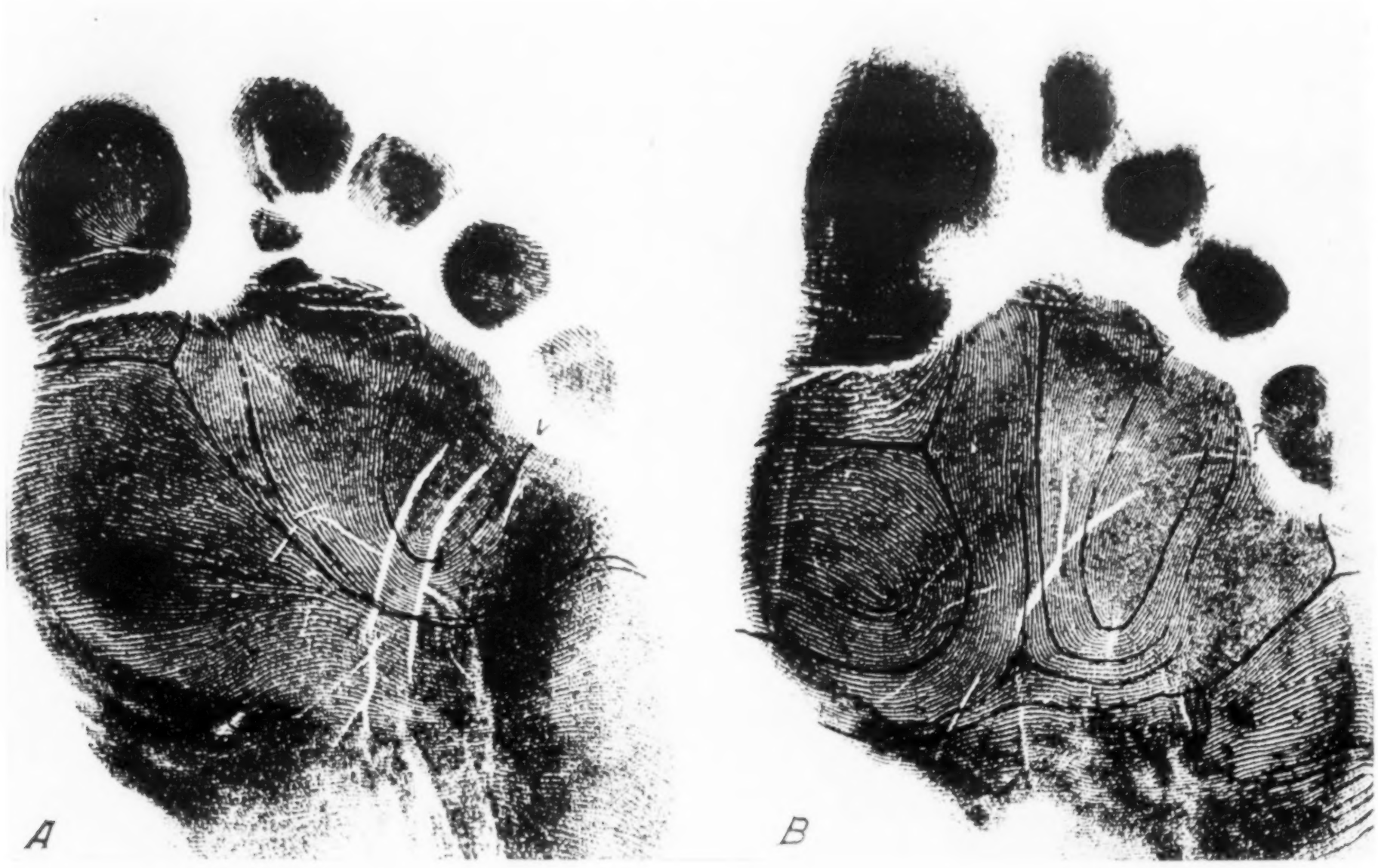
This rolled finger print of the female gorilla "Dinah" in the New York Zoological Garden has been enlarged about three times. As J. H. Taylor, finger-print expert of the Navy, points out, it shows that the ridges in the great apes are quite as perfectly developed as they are in man. Identification experts have found it necessary to make a study of ape's prints, in order that they may be distinguished from those of men in criminal cases. Photograph from René Bache. (Fig. 16.)

all his brothers had starved to death, childless. It may be so, but to believe it requires little less than the religious faith avowed by Tertullian: "*Credo quia absurdum est; credo quia impossibile.*"

Without answering the "why" of origin, but agreeing that the friction-skin now probably serves the purpose suggested in the name, and perhaps other purposes, we may investigate its development in the monkeys and apes.

The lemur, a low form in the scale of evolution, has the foot-print shown in Fig. 14, the patterns of which are decidedly simple as compared with those of man. As we rise higher in the scale, we find the pattern becoming more complicated. The progression is not always what we would expect. Thus the hand of the chimpanzee is more human in form than that of any other ape; yet its palm-pattern is less complicated than that of the orang or gorilla, although more complicated than that of the gibbon, which is commonly held to be the most primitive anthropoid. And in man, whose palm-pattern is highly complex, the sole of the foot has a simpler pattern than that of the orang and gorilla—an evidence, some would say, that friction-skin on man's sole is no longer of use to him.

One distinction made by Lydekker is interesting. "In all the lower monkeys that have been examined by both Dr. Hepburn and myself the pattern of the papillary ridges is of the concentric type, in which the central ridges are longitudinal and the external ones form broad ellipses. In the chimpanzee, however, and probably also in some or all of the other manlike apes, the pattern on the balls of the fingers is of the form known as the looped type, which is of common occurrence in the fingers of the human hand. On the finger-tips of man alone occurs the still more com-



HUMAN FOOT-PRINTS DIFFER AS MUCH AS HAND-PRINTS

The toe and ball of the foot have well marked patterns, but the human heel is usually marked merely by curved lines, just as is the toe of the lemur. One distinct pattern on man's heel has been found, but it is very rare. In the above prints, heavy lines have been added to show the types of pattern. Photograph from René Bache. (Fig. 17.)

plicated whorled type;[5] and it is thus evident that even in such a minute detail as the arrangement of the lines on the fingers the manlike apes and man stand apart from their kindred, and that in man alone is the most complicated type ever developed, although even in him it is comparatively rare."

USE OF APES' FINGER-PRINTS

This similarity between the finger-prints of great apes and man is not without importance from a practical point of view. In the Navy, for example, where pets are universally kept, monkeys are often found. Suppose there is a burglary in the captain's cabin, and blurred finger-prints are discovered. Suspicion might have been directed at a steward; but if it were shown that these finger-prints were not made by a human being, the ship's mascot would be properly blamed. The possibility of this was great enough to lead J. H. Taylor, finger-print expert of the Navy Department of the United State Government, to have prints made from some of the common types of apes and monkeys, which are kept on file for future use, and some of which are reproduced in connection with the present review.[6] Few who have not given careful study to the subject would be able to say that the finger-

[5] J. H. Taylor points out that this is incorrect. The thumbs of the orang reproduced in Fig. 15 show well-developed whorls. In complexity of finger-tip pattern, as in many other physical characters, man must take his stand on a level with the other primates—he cannot claim to be in a class by himself. It is also in accord with the remark of Darwin, citing Huxley's work, that "in every visible character man differs less from the higher apes, than these do from the lower members of the same order of primates."

[6] These photographs (Figs 14, 15 and 16) were made on May 8, 1915, by Miss Gertrude M. Sullender, finger-print expert at Blackwell's Island, and Patrick Ryan, of New York City, through the courtesy of Park Commissioner Ward. Fig. 16 is an enlargement made by René Bache. Mr. Taylor notes that "the impression taken from the baboon and monkeys' *feet* would all be

prints of a gorilla, shown in Fig. 16, were not made by a human being.

The problem may arise in connection with more serious crime. Every one knows Edgar Allen Poe's detective story, "The Murders in the Rue Morgue," which turned upon the identification of a great ape as the perpetrator of the mysterious crimes. A somewhat parallel case occured in France only last year. The newspaper account says:

"The victim was a young woman, Mlle. Marie Christophle, aged 24, belonging to an old and wealthy family living at No. 43 Cours Sablon at Clermont-Ferrand, an important French provincial city. The family consisted of this girl, her mother, and a brother, Jean Christophle, one year younger than herself. They enjoyed a large income and lived in a fine old house. The son was called as a soldier on the outbreak of the war, but obtained a comfortable position on the staff, which enabled him to live at home in Clermont-Ferrand.

"Mlle. Christophle occupied a bedroom on the fourth floor of the house. At half-past 2 in the morning agonized shrieks in different tones and cries of 'Fire!' coming from this house were heard by the neighbors. The firemen broke into the house and hurried to Mlle. Christophle's room, where the fire was burning.

"They found that it was already nearly extinguished, and soon put an end to it. Jean Christophle and his mother had apparently been busily engaged in trying to put out the blaze. The big old-fashioned wood four-poster bedstead, with canopy, had been partly burnt up.

"In the midst of the ruins, by the side of the bed, lay the dead body of Marie Christophle. The firemen and others at first assumed that she had been suffocated by the fire.

"In due course a judicial inquiry into her death was begun, and at once the interesting fact was established that her death was not due directly to the fire or to the suffocation caused by it. She had received severe blows on the head from sone blunt instrument probably capable of causing death.

"She had also received injuries in many parts of the body which, it is thought, might have been caused by the hands of a powerful man."

Her mother and brother thought these injuries were due to the top of the bed falling on her, and to her falling on a table and chair; and that death resulted from an attack of heart trouble, to which she was subject.

"I do not believe she was attacked by any one," said her brother. "The first information I had of trouble was when I heard her shrieks and then the noise of her body falling to the floor. Then I rushed to her room. No man who had attacked her could have escaped without passing my room and being seen by me."

After some weeks, during which the police made no progress, the police arrested Mme. Christophle and her son, on suspicion of causing the girl's death. There was no direct evidence against them.

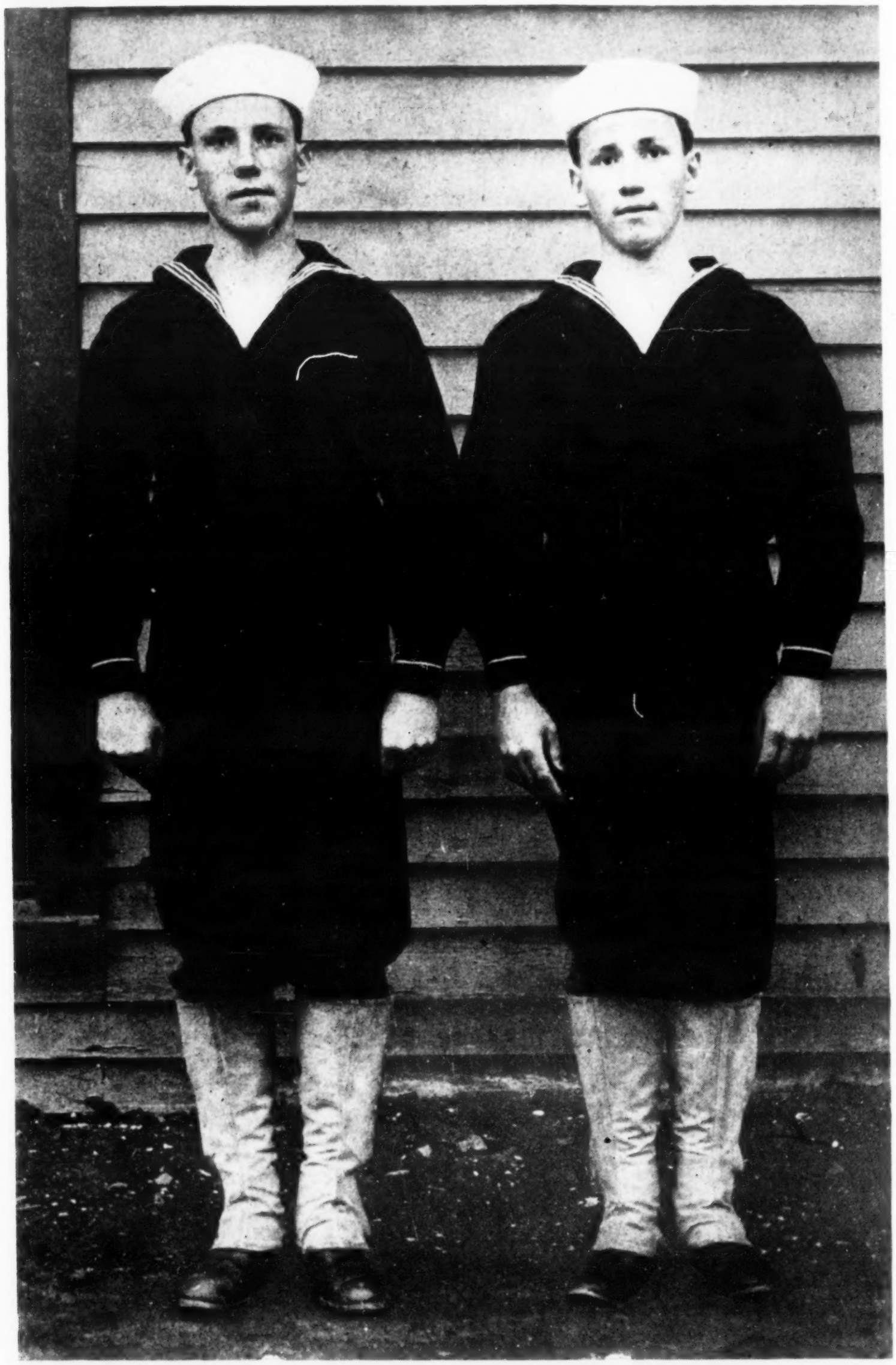
"Then it became known that the police of Clermont-Ferrand were working on the theory that an ape had committed the mysterious crime. This fact first leaked out when it was learned that the police had been examining all the monkeys in the possession of persons in Clermont-Ferrand.

"This led enterprising reporters to the discovery that the police had kept a remarkable collection of finger-prints found in and about the room where the tragedy occurred and upon the body of the dead girl.

"Some of the injuries on the body of the girl were, it was reported, apparently

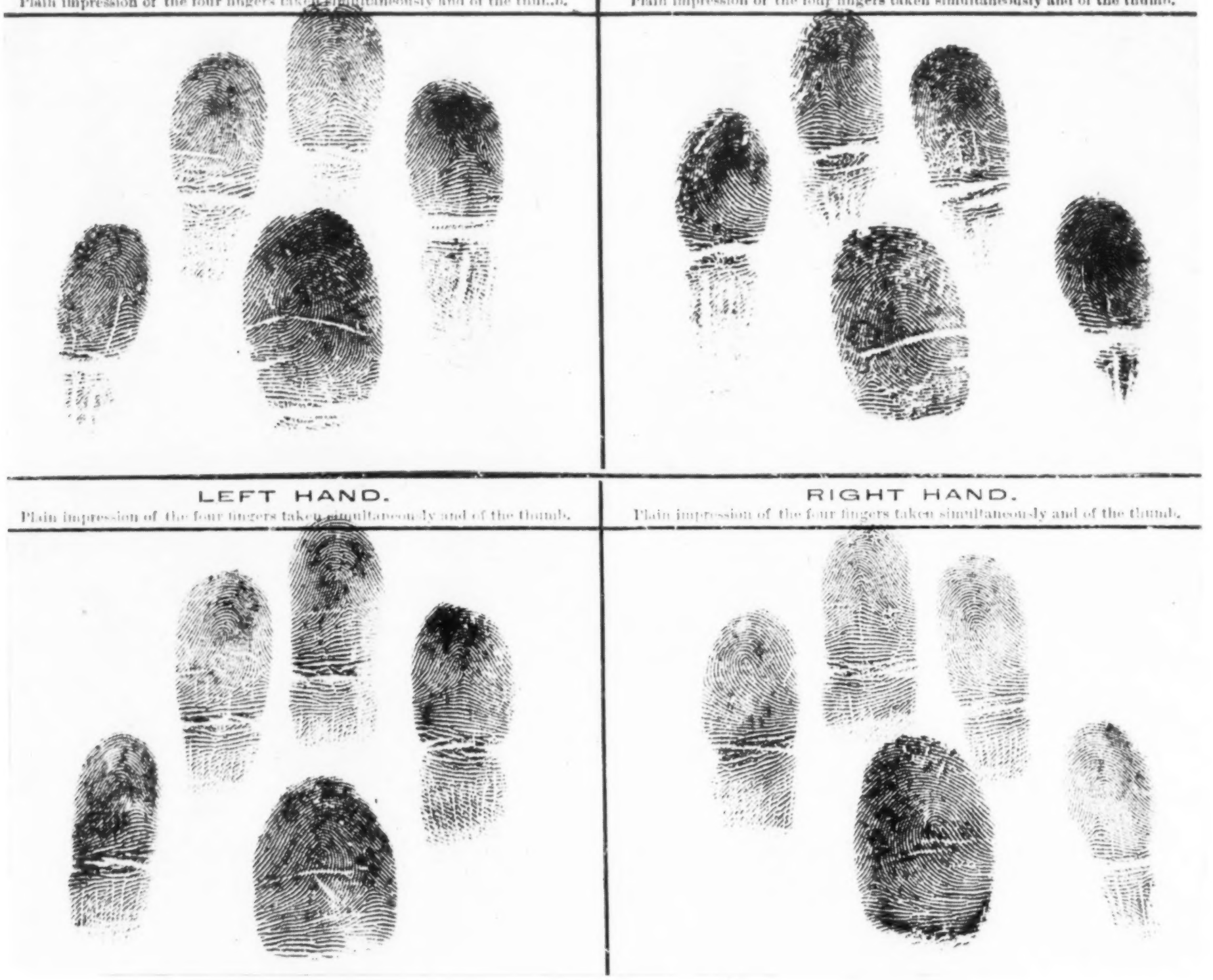
---

classified as almond shaped whorls, but unlike the impressions made by the human hand no deltas are shown, which would prevent a further classification of the impressions by ridge tracing. It seems quite remarkable that in the higher development of the primate family the ridges in the feet should have obtained a development so similar to the ridges in the fingers of a human being, that at a glance you would take the impression to have been made by a hand of a person that had performed much manual labor, while the Lemur shows only a blur without the significant lines."



SUPPOSED "IDENTICAL" TWINS

The only measurable difference between these two young Irishmen is an inch in height; if they are separated few people can tell one from the other. Their commanding officer was obliged to put them in separate companies, and even then did not avoid frequent embarrassments. Their finger prints, as shown in the following illustration, are remarkably similar but not identical: a fact which may be taken to show that heredity governs the main outlines but not all the details of the finger pattern. Photograph from J. H. Taylor. (Fig. 18.)


LEFT HAND.
Plain impression of the four fingers taken simultaneously and of the thumb.
RIGHT HAND.
Plain impression of the four fingers taken simultaneously and of the thumb.
LEFT HAND.
Plain impression of the four fingers taken simultaneously and of the thumb.
RIGHT HAND.
Plain impression of the four fingers taken simultaneously and of the thumb.

FINGER-PRINTS OF SUPPOSEDLY "IDENTICAL" TWINS

Above are the finger-prints, supplied by J. H. Taylor of the Navy Department, of the two young sailors shown in Fig. 18. The reader might examine them once or twice without seeing any differences. Systematic comparison reveals that the thumbs of the left hands and the middle fingers of the right hands particularly are distinguishable. Finger-prints as a means of identification were popularized by Sir Francis Galton, the founder of eugenics, and their superiority to all other methods is now generally admitted. In addition to this practical usefulness, they also furnish material for study of the geneticist and zoologist. (Fig. 19.)

caused by fingers and thumbs of enormous strength. They were not the fingers and thumbs of young Christophle, and they differed in type from those of any other man preserved in collections of finger-prints. The same finger-prints were found on the back of a chair in the bed-room and upon the window-pane.

"Five monkeys were found by the police in Clermont-Ferrand, but they were all small, and their finger-prints could not possibly have been confused with those of a man.

"It was clear that if one of the simian family was concerned in the tragedy it must have been a great ape, such as an orang outang, a gorilla, or a chimpanzee. If that was so it must have belonged to some wandering showman who had passed through the town. The police are now hunting for such a showman who passed through the town at the time of Mlle. Christophle's death.

"A theory has been put forward that the ape escaped from its house or cage during the night, ran through the empty streets of the town and was attracted by the light in the fourth-story window

of the Christophle house. Then the ape ran up a rain-pipe, reached the window, entered the room, attacked the girl, beat and choked her to death and upset the lamp in the struggle. Finally it escaped in the way it came."

GALTON'S PIONEER WORK

Whatever the outcome of this case, there is no room for doubt about the utility of finger-prints in police administration nowadays. Their use was first systematized and made popular by Sir Francis Galton, who had heard of a primitive form of finger-print registration in Bengal.

After collecting and classifying thousands of prints, Galton reached the conclusion that the chance of two finger-prints being identical is less than 1 in 64,000,000,000, so if the number of human beings alive is reckoned as 1,600,000,000, there is a smaller chance than one in four that the print of a *single* finger of any given person would be exactly like that of the same finger of any other member of the human race. When two fingers are considered, the improbability of identity becomes squared, with three fingers it is cubed, and so on. As police officials usually take all ten fingers, the chance of finding any two sets alike is wholly outside the range of human probability: actually, all possibility of error is eliminated. Galton spent a great deal of time working up a classification of finger-print patterns which would permit them to be indexed and readily referred to; his system, with some improvements by Sir Edward R. Henry of the London Police Department, is now in general use in civilized countries and has proved thoroughly satisfactory.

Emphasis has been given to the impossibility of finding two sets of prints that are identical; this impossibility extends even to the prints of duplicate or so-called identical twins, who might be quite indistinguishable by photograph, by Bertillon measurements, or by any other system of identification that has been devised. Nevertheless the prints of twins of this sort are much more alike than the prints of two persons picked at random, or even of two ordinary brothers—a fact which indicates that the main features of the pattern, at least, are inherited.

J. H. Taylor has furnished the photograph reproduced in Fig. 18 of two young Pennsylvania Irishmen who enlisted in the United States Navy at about the same time and were sent to the same training school. One was 1 inch taller than the other; but when they were not together no one could tell which of the twins he was addressing. The commanding officer was so much worried that he attempted to evade the problem by putting them in separate companies. Their likeness led to troubles which finally resulted in their withdrawal from naval life. Their finger-prints, reproduced in Fig. 19, will probably at first glance be indistinguishable to the reader, but more careful study shows slight differences which would give them different classifications and permit no chance of confusion in the mind of an expert.

INFLUENCE OF HEREDITY

The finger-prints of these twins suggest that heredity largely, but not wholly, determines the pattern. Galton made the first serious study of this point, taking ordinary pairs of brothers. He found there was more often likeness between their finger-prints, than was the case with two individuals taken at random, a fact which indicates hereditary influence.

Since then Dr. Harris H. Wilder, Professor of Zoology at Smith College, Northampton, Mass., has given especial attention to the inheritance of palm and sole patterns. Describing the patterns of duplicate twins, he points out[7] that the general type is usually the same, although there is room for much variation in the details. "It is as though identical forces had directed the development in the two individuals, but that the material had yielded a little unequally to the strain of growth, a given area being a little more expanded

[7] *American Journal of Anatomy*, Vol. iii (1904), pp. 387–472.

and consequently covered by a few more ridges in one than in the other."

"This occasional wide discrepancy in the number of ridges suggests that we are on the border between characteristics which are duplicated [in duplicate twins] and those which are not. While the correspondence between the main lines and areas, the patterns and other figures, and even the number of ridges in most cases is nothing short of remarkable, the law seems to fail at about the latter point, and if we turn to the '*minutiae*' of the ridges,[8] that is, the forkings, interruptions, interpolations and isolations, we find that the limit of resemblance has been passed, and that whatever law of heredity or of construction has caused a similarity of form or arrangement in the larger parts, it is here no longer binding. Perhaps in this way we may be led to approximate the question asked by Galton, 'What is the minutest biological unit transmissible by heredity?', since in individuals that arise from one egg and thus possess, presumably, the same inheritance, the main lines, areas, patterns and other large features are duplicated exactly, or as nearly as the ridges will allow them to be, while the ridges themselves with their minutiae are not."

PRINT OF A SPLIT FINGER

A striking evidence that the minutiae are not due to heredity was discovered by Wilder when he observed a man with six fingers, one of the original five having split in the course of development. The pattern of these two finger-tips, which in origin were halves of the same finger, was not identical.

Given the hereditary basis of finger-patterns, it might be expected that different races would differ in this characteristic. Galton, however, concluded from a study[9] of English, Welsh, Hebrew, Basque and Negro finger prints that "there is no *peculiar* pattern which characterises persons of any of the above races." Prof. Wilder has made an interesting study[10] of negro and white palm and sole prints, and finds that here distinct races have distinct racial formulae, which are characteristic but not invariable. No pattern was found among negroes, which could not be duplicated among whites; yet a certain pattern was more common among negroes and another among whites. Further, there was found much more individual variation among the whites than the negroes, the latter exhibiting only sixteen different patterns, while the whites disclosed forty-four. It is probable that the negro tends to be more primitive in this respect than does the white race.

There appears to be no constant difference between the two sexes in respect of friction-skin patterns, but Ch. Féré believes he has found some differences which are correlated with intelligence. When taking the hand prints of idiots, he found that in many cases their left thumbs were not wholly opposable.[11] He further observed that the most complex forms of finger-print patterns are on those digits which are most differentiated functionally: *i. e.*, the thumb and first finger, and the great toe. Finally he states,[12] but without adequate evidence, that "there is a correlation between the complexity of the patterns of the papillary crests and the development of the intellect and senses."

The problem of working out the exact mode of inheritance of friction-skin patterns appears at present to be almost hopeless; certainly Wilder's hypothesis[13] that they are due to "two or more Mendelian factors" is not yet proved. But the study is full of interest and offers promising results not only to geneticists, but to taxonomists, morphologists and ethnologists, as well as policemen. And as Wilder points out, "Unlike most biological material, that concerned here is readily obtained,

---

[8] To those engaged in finger-print identification, these *minutiae* are known as "ridge characteristics," and classified as abrupt beginnings and endings of ridges, bifurcations, islands, etc.

[9] Finger-Prints, by Francis Galton. London, 1892, Chapter XII.

[10] *American Anthropologist*, Vol. xv (1912), pp. 189–207.

[11] *Comptes rendus de la Société de Biologie*, Tome 50, p. 827.

[12] *Ibid.*, Tome 48, p. 1115.

[13] *Biological Bulletin*, Vol. xxx, No. 3, March, 1916. There is a good bibliography attached to this paper.

and easily kept, a series of prints being for most purposes more convenient for study than the actual objects; the prints, too, are more accurate records of the facts than any drawings or even photographs." If genealogists would begin recording the finger prints of all the living individuals in their studies, a great deal of valuable material could be accumulated without difficulty.

Mutations in Walnuts

An oak-like mutation which occurred in the California black walnut and led some observers to suppose that a natural hybrid had been produced between oak and walnut, was described in this journal (VI, No. 12, December, 1915) by Prof. E. B. Babcock of the University of California. He has now published further evidence that it is really a mutant, in *U. of C. Pub. in Agric. Sciences*, September 20, 1916 (II, No. 3). Pollen from the oak-like mutant was applied to pistillate flowers of the California walnut; the resultant trees were all normal California walnuts. When this F_1 generation was self-pollinated, twelve trees of *Juglans californica* were secured and six of the var. *quercina*. Prof. Babcock therefore thinks it likely that "the genetic relationship between *californica* and *quercina* is a difference in a single factor of the same Mendelian reaction system." A parallel mutation has been discovered in the Northern California walnut (*Juglans hindsii*).

Hereditary Nomadism and Delinquency

The study of nomadism, recently initiated by C. B. Davenport (see the JOURNAL OF HEREDITY, April, 1916), is continued by J. Harold Williams in the *Journal of Delinquency*, I, 4, 209–233, September, 1916. Dr. Williams publishes charts showing the family history of twenty-four nomadic delinquent boys, and also data about the families of twenty-four non-nomadic delinquents picked at random; and as there is more nomadism in the families of the nomadic boys than in those of the non-nomadic, he concludes that there is basis for the belief that nomadism (expressed often in the form of truancy in his cases) is an inherited trait. Aside from the difficulty of defining the trait, there is a lack of critical cases. There are doubtless some hereditary factors back of nomadism, truancy, and "various kinds of periodic behavior," but the studies so far made do not throw much light on the method of heredity.

A Yellow Sweet Pea

To produce a yellow sweet pea has been for years the ambition of sweet pea breeders, just as rose breeders have longed for a blue rose. The difficulty in each case is that the desired color is not found in the species, and the breeder is not able to secure it by combination with some other species. At the eighth annual meeting of the American Sweet Pea Society, David Burpee expressed doubt as to whether the yellow variety could be secured. If it does come, it probably will be as a result of crossing *Lathyrus odoratus* with some other species. Unfortunately, it does not cross readily; in spite of the efforts of many breeders, it is said that no hybrid has ever been obtained between the sweet pea and any other species even of the same genus.

COOPERATION IN PRODUCTION OF CALIFORNIA GRAPE-FRUIT

PLANT breeding in the past has proceeded mainly through the efforts of individuals. In a few industries it has now become the object of cooperative effort. The latest example is furnished by the grapefruit growers of California.

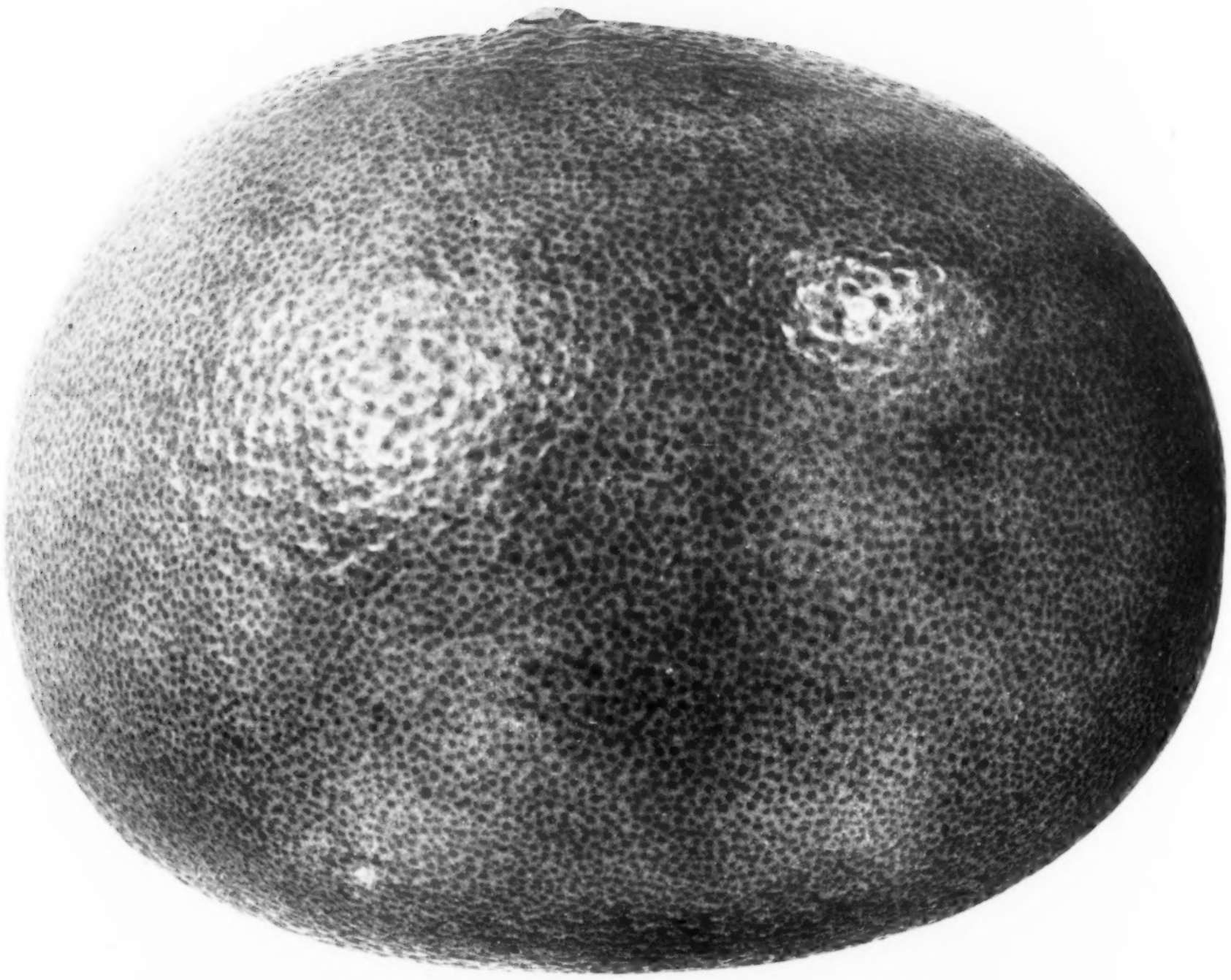
There are, it must be remembered, two methods of procedure in plant breeding: (1) the creation of new varieties; (2) the improvement and standardization of existing varieties. The former is the more spectacular and interesting, and has been much practised by plantsmen, whereas animal breeders of the last generation have limited themselves mainly to perfecting the breeds they now possess. This perfection of existing varieties is no less important in plant breeding, and has been undertaken in an organized way by "The Grapefruit Club."

Most American grapefruit are produced in Florida, the industry in California amounting to only 300 carloads this year. The principal variety grown in California is the Marsh, which originated about thirty years ago in the grove of C. M. Marsh at Lakeland, Fla. He found one tree which produced a smooth, flattened, seedless fruit: its origin is not known, and it may be either a seedling or a bud sport. The tree was killed by the "great freeze" in the winter of 1894-95, just after Mr. Marsh had made plans to propagate it extensively, and had cut about 10,000 buds, which he was storing. He had also grown many seedlings to bud, but most of them were killed. He succeeded, nevertheless, in propagating a number of Marsh trees. In the spring of 1895 a representative of Riverside, Cal., citrus growers was sent to Florida to get new varieties, and succeeded in securing a quantity of Marsh budwood, which formed the first introduction of this variety to California. One of these parent trees is still bearing in Riverside. A number of distinct introductions of the same variety have been made in later years.

In Florida the Marsh is now the favorite variety, although H. H. Hume says it lacks flavor and is surpassed by other varieties. In California there is hardly a question about its superiority; it is generally considered to be a better fruit there than in the place of its origin. The same is true of the Bahia Navel Orange, which, under the name of Washington Navel, is a more attractive fruit in California than in either its Brazilian home or in Florida;[1] and the explanation of this is to be found in the climate. The cold California nights give the fruit a better color than it has in Florida; while the dry, sunny summer results in the production of more sugar, the translocation of which to the fruit is again favored by the sharp drop in temperature at night. The same conditions likewise result in the production of more acid. Cold nights and sunny days therefore give the California fruit more "character" and color; it is both more sweet and more sour. The moister and more equable climate of Florida, on the other hand, while it produces a fruit with less pronounced flavor, tends to develop the more delicate features of the flavor, which are due to ethers or volatile oils.

These varying climatic results are easily seen in the Marsh grapefruit, which when properly matured in California is said to have a richer flavor than in Florida. Commercially, California cannot compete with Florida on even terms in supplying grapefruit to the eastern market, because the latter can market fruit at much less expense. The California growers, aside from supplying the home market, endeavor to supply the eastern market during late summer and early fall, when little

[1] See "Washington Navel Orange," by A. D. Shamel, JOURNAL OF HEREDITY, Vol. vi, No. 10, pp. 435–445, October, 1915.



THE APPROVED TYPE OF MARSH GRAPEFRUIT

It is a flattened fruit with a smooth, fairly thin skin, no seeds and an abundance of juice. It originated under unknown circumstances in Florida a generation ago, and quickly became the most popular variety in America. All the California commercial growers have agreed to produce a grapefruit like the above, and no other. Photograph from the U. S. Department of Agriculture. (Fig. 20.)

or no Florida grapefruit is being shipped.

In the past, California grapefruit has usually been picked in winter, and has been considered inferior to the Florida fruit. It is now believed that this inferiority is due to premature picking: that the fruit does not really ripen until about May. The Grapefruit Club will therefore adopt a "standard of maturity" just as the orange growers have done. No orange may be shipped unless it contains eight parts of soluble solids (mostly sugar) to one part of acid, and the Interstate Commerce Commission prosecutes any grower who ships his fruit before it is legally ripe. The Florida standard for grapefruit is seven parts solid to one of acid; this may be modified in California.

The Grapefruit Club embraces the growers of 60% of all the grapefruit produced by California, all of them members of the California Fruit Growers' Exchange. They have decided not only to market their fruit according to standard, but to eliminate from their groves all varieties except the Marsh, and further to eliminate all Marsh except one approved type. Due to bud variation and careless propagation of inferior variants, there are now a number of types of Marsh grown in California: the standard is a smooth, flattened, juicy fruit, another is rough skinned, a third corrugated, a fourth full of seeds. The members are going over their groves, eliminating all trees that do not bear standard fruit, and topworking them or replacing them with new trees.

The two largest growers of grapefruit in California are not members of the Exchange and therefore not members of

A VARIATION OF THE MARSH GRAPEFRUIT

Like all other citrus fruits, the grapefruit is much subject to bud variation. On a good Marsh tree, a single limb will sometimes appear bearing rough, dry, pithy fruits like the one shown above. If the grower is not watching his trees carefully, he may propagate from this limb and then have a number of entire trees bearing the same worthless type of fruit. This is exactly what has happened to a considerable extent in the California citrus groves; the growers are now eliminating all inferior bud variations, including the one shown above, and retaining only approved types, taking care to propagate from the most productive trees of these. Photograph from the U. S. Department of Agriculture. (Fig. 21.)

the Grapefruit Club. They worked over their groves four years ago, eliminating all but the best type of Marsh; it was their success, indeed, that moved the Grapefruit Club to organize and act. The result will be that the whole California grapefruit industry is on a common basis, uniting on a single strain of a single variety, keeping this variety up to the mark by maintaining a performance record for every tree and eliminating those that show undesirable variation. In this effort they have the coöperation of the U. S. Department of Agriculture, and the greater part of the grapefruit buds propagated during the last five years have been pedigree buds furnished by the Department, which in the seven years of its bud selection work in California has distributed more than 2,000,000 buds of all kinds to citrus growers—all these buds being furnished gratis by owners of groves who were aiding the Department in its investigations.[2]

It has long been evident that the future of agriculture in the United States depends on organized coöperation of small landholders. The first

[2] See "Bud Variation," by A. D. Shamel, JOURNAL OF HEREDITY, Vol. vii, No. 2, pp. 82–87, February, 1916.

attempts were naturally in the direction of coöperative marketing. Extension of this coöperation to the improvement of varieties and breeds will have commercial results that can hardly be overestimated. Some of the live-stock breeders already have their "circuit bulls;" many have milk or butter-fat tests. Horticulturists are in the nature of things enabled to proceed even more rapidly, and the radical action of the California grapefruit growers will undoubtedly be followed by other branches of agriculture, as fast as the progress of genetics marks the way.

Another German Proposal to Increase the Birth Rate

A. Zeiler in *Die Grenzboten* (March, 1916) says in sum: The serious danger of being outnumbered by our eastern neighbors must be averted at all risks. Since the rising standards of living make large families nearly impossible, and since the gap between the mode of living of the unmarried or childless and the large family are the strongest reasons for a decreasing birth-rate, large families must be encouraged through economic assistance. A bachelor tax alone is inadequate, and the disadvantages of exemptions from taxation of heads of families are greater than the advantages. Only a proper balancing of the family burden through a general and proportional subsidy or pension will really help. These subsidies must be large enough to be effective and yet not so large as to eliminate the very principles upon which the family rests: the sense of responsibility and the willingness to sacrifice. The subsidy should be in the form of a gift for the girl who marries; annual contributions to the expenses of every home, whether there are children or not; and a grant for every child, graded according to age and education received. A tax amounting to about 3% of the total income, after an absolute minimum and a proportional subsidy had been deducted, would furnish the funds. A bachelor, the head of a family without children, and the head of a family with five children and an income of 4,000 M., for example, would pay a tax of 816 M. The childless family, however, would receive a compensation of 600 M. per annum, the family with five children not over 14 years of age, an additional sum of 712 M., while the bachelor would receive no compensation whatever.—Abstract in *American Journal of Sociology*.

Ewing's Study of an Aphis

Having bred a plant-louse (*Aphis avenae* Fab.) for eighty-seven generations, Prof. H. E. Ewing describes his study in the *Biological Bulletin*, XXXI, 2, pp. 53–113. The insects formed a parthenogenetic pure line, in which six different fluctuating variations were marked. Selections were made for ten or more successive generations in the case of three of these characters; for forty-four successive generations in one character; and were carried out in both plus and minus directions in the case of two characters. In all of these cases no summation of effect was produced by selection. The writer concludes, therefore, that such variations are not due to the germ-plasm. "The pure line theory," he holds, "applies to parthenogenetic arthropods as well as to forms that reproduce by budding, fission, or self-fertilization," but he points out that it is a great mistake to attempt to apply it to animals that reproduce sexually. A few abrupt variations were noted, but were not found to be inherited any more than the small fluctuations which were continually occurring.

WHAT GENETICS IS

"An exact determination of the laws of heredity," says William Bateson, "will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be clearly foreseen."

To gain this knowledge is the object of the science of genetics, which proceeds, in practice, largely by means of plant breeding and animal breeding, for the reason that heredity is less complicated in these organisms than in Man, and its operation can be more easily made out. The knowledge so gained finds its application in methods for the improvement of cultivated plants and domesticated animals and, most important of all, in the improvement of the human race through the science of eugenics, which was defined by its founder, Francis Galton, as "the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally."

THE AMERICAN GENETIC ASSOCIATION

is an incorporated organization, cooperative in nature. It is devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks.

It owns the JOURNAL OF HEREDITY, which is published monthly and sent free to each member.

REQUIREMENTS FOR MEMBERSHIP

Membership is composed of men of science, teachers, publicists, physicians, clergymen, parents, students, horticulturists and breeders of live stock, etc., throughout the world.

Subject to the approval of the council, any person interested in the improvement of the human race or the creation of better varieties of plants and animals, is eligible for membership.

The secretary will be glad to correspond with those interested, and to send a copy of the magazine for examination.

Annual dues, giving the right to attend all meetings and receive the JOURNAL OF HEREDITY, are $2; life membership is $50.

If you want to become a member, or if you know anyone who you think is eligible for membership, write to

THE AMERICAN GENETIC ASSOCIATION

511 Eleventh Street Northwest **Washington, D. C., U. S. A.**